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### *History of the Steam Engine, with a reply to the Criticisms to whi h the first publication of the article gave rise.* By M. ARAGO.

[From the Annual of the Board of Longitude, for 1836.]

TRANSLATED BY LIEUT. A. A. HARWOOD, U. S. N.

[CONTINUED FROM PAGE 20.]

1769. *James Watt.**

Before commencing the review of Watt's invention, I ought, perhaps, to transcribe here the titles of the various patents which he obtained during his long and glorious career. The reading of these titles would shew clearly the object of the important improvements which this illustrious machinist introduced successively in the machines of his predecessors; it would un-

* James Watt was born at Greenock, in Scotland, in the year 1736, of poor but respectable parents. The extreme weakness of his constitution did not seem to promise him a long life. This unfortunate circumstance at least developed in him at an early period, habits of retirement and application without which much is rarely accomplished. Young Watt attended one of the public free schools, called, in Scotland, *grammar schools*, until his sixteenth year, afterwards his parents got him an apprenticeship in a small workshop where they made compasses, scales, some kinds of philosophical apparatus, quadrants, and various impldments used in fishing: he remained there four years. Finally Watt went to London and lived with a mathematical instrument maker. There a particular piece of work occupied him near the door of the workshop the whole of a winter's-day, and he was seized with a violent cold of which the physicians could not cure him perfectly. He then resolved to try the effect of his native air, returned to Scotland and there set up a modest establishment on his own account. In the year 1757 the University of Glasgow appointed Watt, then 21 years of age, keeper of its collection of models. With this title he received accommodations

deceive those, on the other hand, who believe, without any foundation, that the steam engine now in use was contrived at once, and by one person; but the necessity of abridging this memoir obliges me to enter at once into the subject in hand.

### *Of the Condenser.*

That the atmospheric engine, or *Newcomen's engine,* should produce any serviceable effect, it is necessary, in the first place, that at the instant when the descending movement of the piston begins; there shall be a vacuum below

in the college, with permission to continue his employment there. Robison was among the students of the University. He became intimate with Watt, confided to him the plan which he had conceived of applying the steam engine to locomotion, and engaged him to interest himself in bringing it to perfection. Some experiments made by the artists in 1759, 1761, and in 1762, led to no result: but in 1764 some new attempts were quite successful. Employed as a mere workman to repair one of Newcomen's engines which belonged to the philosophical apparatus of the University, Watt discovered defects in it which the smallness of the model rendered more apparent; but which would also have existed in large machines. Such is the date and origin of the improvements explained in the text. Many years, however, glided away before Watt could submit them to a decisive proof. In 1764, he quitted the University after getting married, and was employed for some time as a surveyor. His first improved machine was not finished until 1768; it was on a tolerably large scale, for the cylinder was eighteen English inches in diameter. Dr. Roebuck who, by his pecuniary advances, had furnished Watt with the means of completing his work, caused the new machine to be established at Kinneal on the shaft of a coal mine belonging to the Duke of Hamilton. All these names appear to me worthy of being preserved; they belong to history. In this same year, 1768, Watt solicited his first patent; he did not obtain it, however, until 1769. At last Matthew Boulton, of Birmingham, became his associate in 1773, after the voluntary withdrawal of Dr. Roebuck. The fortune of this manufacturer, the capacity and activity of his mind, the personal relations which he had contracted with a multitude of individuals belonging to all classes of society gave the liveliest impulse to the enterprise. The privilege granted by the patent was about to to expire, however, before the new manufactory of Soho had yielded any real profit. Boulton made application to the authorities, solicited the co-operation of his numerous friends, interested the court and the city in his plans, and by his numerous and judicious proceedings obtained, of Parliament, the extension of the original privilege until the year 1800. Beginning from this period (1775) the association of Watt and Boulton prospered in the highest degree. The sterile hill of Soho, near Birmingham, where the eye of the traveller hardly discovered the hut of a game keeper, was covered with beautiful gardens, sumptuous habitations, and with workshops which both from their extent, and from the importance and perfection of the works executed in them, became in a short time the first in Europe. The discoveries of Watt were of too immediate and popular application to render academic titles any accession to the renown of this great mechanician. We may remark, however, that the principal learned societies, those of Edinburgh and London for instance, hastened to admit him as a member. The Institute of France elected him a correspondent in 1808; and in 1814 bestowed upon him the highest reward in its power, by nominating him one of its *eight* foreign associates. Having attained an advanced age, possessor of a brilliant fortune, the fruit of his noble and laborious works, enjoying the respect and esteem of the whole world, Watt gave up his commercial affairs and retired to Heathfield his country seat near Birmingham. There, the patriarch of British industry, always benevolent, modest and reserved, as when in his youth he kept the apparatus of the University in order, his days glided on peaceably in the society of a small circle of friends. In 1807 Watt made a journey to Scotland. Upon his return his health was much enfeebled. At length he died on the 25th of August 1819 after a short illness, at the age of 84 years. A statue is about to be erected to Watt, in one of the squares of Birmingham at the public expense. The most distinguised portion of the English community have shown an honorable eagerness to enroll themselves among the subscribers.

it; secondly, that during the ascending motion, the steam which issues from the boiler into the cylinder shall not lose any of the elastic power which it had acquired at the expense of a considerable quantity of fuel.

The first condition requires that at the instant condensation takes place, the water which is injected should cool the sides of the cylinder; otherwise the steam to be condensed would retain a good deal of its elasticity and would oppose a serious obstacle to the descending motion of the piston produced by the atmospheric pressure. The second condition exacts, on the contrary, that the sides of the cylinder should be very hot. In fact, steam at a temperatue of 212° Fab. does not retain its proper elastic power in entering a vessel unless the sides of the vessel are themselves heated to 212°. If the temperature of the sides be less, the current of steam soon loses its original heat, and more or less of the elastic force which it possessed. Thus during the descending movement of the piston, the sides of the metallic cylinder in which it works ought to be as cold as possible, if the condensation is to take place in this cylinder; during the ascending movement, on the contrary, the sides should be at 212°. The cooling is effected by projecting water not only in the midst of the steam but also on the inner surface of the cylinder. As to the heating of the cylinder which ought to follow this operation, the question is how is it to be duly effected? The steam will, of itself, produce the desired heat after a time; but it will be but slowly, and for this reason the ascending movement of the piston being very slow, the engine will not perform in twenty-four hours the work which without this sort of impediment, might have been calculated upon. We may also remark, that the steam proceeding from the boiler does not heat the cylinder without some loss of its own heat, in other words ,without being condensed; but steam is costly (even though the water from which it is generated cost nothing,) on account of the fuel used in its production. That there may be no doubt of the attention which should be paid to this consideration, I will observe that the quantity of steam employed to heat the sides of the cylinder would fill the interior space many times, so that the expense of steam, or that which is the same, the expense of fuel, in short the actual outlay of money necessary for setting the engine in motion would be *many times* less, if the necessity for the successive heatings and coolings of which we have just spoken could be done away with. Such is precisely the problem which Watt solved by a method which allows the cylinder always to remain at 212°. For this purpose he found it necessary :—

*To effect the condensation of the steam in a separate vessel, entirely distinct from the cylinder, and only communicating with it by a straight tube.*

Let us explain this ingenious process, which will always constitute Watt's principal claim to the gratitude of posterity.

If a free communication be made between a cylinder filled with steam, and a vessel void both of steam and air, the steam in the cylinder will pass partially and very rapidly into the vessel, and the rush will not cease until the elasticity becomes equal throughout. Suppose the vessel to be kept cool inside and out by means of an abundant and continual injection of water; then all the steam with which the cylinder was originally filled will pass in and be condensed successively; the cylinder will, in this way, be cleared of steam without its sides becoming cooled, and the new supply of steam with which it may be necessary to fill it a moment afterwards, will not lose any portion of its elasticity.

A vessel thus separated from a cylinder, and into which the steam of the

cylinder occasionally passes, is called *a condenser*. This is the most important part of Watt's engine.

The operation of the *condenser* which has just been explained, was due to two circumstances, first to its containing cold water, and second that the remaining space inside of it was void of elastic fluid.* After the condensation of steam has taken place, these two causes of success disappear; the condensing water becomes heated by absorbing all the caloric contained in the steam, a considerable quantity of vapour is generated at the expense of this hot water; finally the cold water contains atmospheric air, which is disengaged as it becomes heated. If, after each operation, the water, steam, and air contained, be not removed from the condenser in will cease to produce its effect. Watt removed them by means of an ordinary pump called an *air pump*, the piston of which was connected with the working beam of the engine. When the effect of one of Watt's engines is calculated, it is necessary then to take into account the portion of power used to keep the air pump in operation. This deduction, however, is but a trifling matter compared with the loss which the condensation of steam upon the cooled sides of the cylinder produced in the old method.†

### *Double Acting Engine.*

The atmospheric engine, whether the injection of cold water operates in the middle of the cylinder or in a separate condenser, has no real power except during the descending stroke of the piston. It is then, and then only, that the weight of the atmosphere produces its effect. During the ascending movement this weight is counterbalanced by the pressure of steam which forces the piston from below upwards. The motion is then determined solely by a counterpoise which hardly exceeds the weight of the piston, making up for the friction which the latter encounters from the sides of the cylinder. This is not an inconvenience when the engine is employed in pumping up water from mines. The descending stroke of the piston determines, in fact, a corresponding motion in the extremity of the working beam with which it is connected, and hence an *ascending* motion at the other extremity. During this motion the water situated vertically under the last

* Strictly speaking, a vessel is never entirely free from elastic fluid as long as it contains water, for vapour is disengaged from the coldest water; but when the injected fluid is of no higher temperature than the ordinary temperature of the atmosphere, we may disregard, in practice, the vapour which rises from it.

† The brief remarks which follow will lead to an exact idea of the commercial importance of the invention of the condenser. To grant permission to substitute their machines for Newcomen's, Watt and Boulton exacted the value of *one-third of the quantity of coal saved by each new engine of the same power*. A preliminary experiment made upon two engines of either kind, of precisely the same dimensions, showed the amount of the saving, for example upon a thousand strokes of the piston. A simple proportional calculation decided afterwards the tax to be received as soon as they ascertained the number of strokes which the engine used made monthly. Watt and Boulton determined this number by means of a piece of clock work attached to the piston, and so arranged that each stroke would advance the hand one division. This piece of mechanism, or counter, was enclosed in a box having two keys, which was opened upon every settlement of accounts in presence of an agent of the inventor, and of the director of the mine. In the Chatwater mine in Cornwall, where three engines were in operation, the proprietors bought the right from the inventors for an annual sum of $12,000, which proves that the substitution of the *condenser* for the injection which, before that invention, took place in the cylinder, had there caused a saving of fuel of more than $36,000 annually.

mentioned extremity of the beam, is raised by a quantity equal to the descent of the piston in the cylinder. When the piston of the pump descends there is no manner of use in accelerating the motion, and any power employed for that purpose would be entirely wasted. The operation is analogous to that of drawing water from a well; we let the bucket go down by its own weight without ever imagining a necessity for employing a motive power for that purpose. Thus for the purposes of draining, the atmospheric engine is perfect, and its intervals of action do not make it defective; it is not so, however, when this species of engine is used as a motive power for machinery. The machinery in that case must be in rapid action while the piston is descending; but during the ascending stroke must either stop or only continue in motion in virtue of the velocity previously acquired. An engine therefore which would retain its power during the *two* opposite motions of the piston would present real advantages. Such is the object of the engine invented by Watt which is called the *double acting engine.*

The atmosphere has no part in the action of this engine. The cylinder is closed at the top by a metallic cover, with a hole in the centre well packed with greased hemp, to allow the free action of the piston rod without giving vent to the steam. In this way the piston divides the cylinder into two tight and distinct spaces. When it descends the steam comes freely into the upper space through a tube suitably placed for this purpose, and impels the piston from above downwards, as the pressure of the atmosphere operated in the atmospheric engine. This motion meets with no obstacle provided that during its continuance the lower part of the cylinder, and the lower part alone, is in communication with the condenser. As soon as the piston is entirely down, matters are completely reversed by the simple movement of two valves. Then the steam which the boiler supplies passes below the piston, which rises, and the steam above it which a moment before produced the descending motion, rushes into the condenser, with which it is in turn in free coummunication, and is condensed. A contrary arrangement of the same valves restores every thing to its original state as soon as the piston has gained the extremity of its stroke. The engine goes on in this way, indefinitely, with nearly the same power whether the piston ascends or desc nds; but it is worth remarking that the expense of the steam is double that in an atmospheric, or single, acting engine.*

### *Engines using Steam Expansively.*

In the double acting engine of which I have just spoken, the piston is alternately impelled by the steam from above downward and from below upward. If the boiler is in free communication with the cylinder *during the whole time* required by each of these oscillations, the piston will be subjected

* Papin, as I have before observed, foresaw in 1695 that steam engines would not always be exclusively employed for draining mines. At this period he had already indicated a method for connecting the piston rod with a revolving wheel, and for changing the reciprocating rectilinear motion of the piston into the rotary motion of the wheel. The want of continuity in the action of the atmospheric engine also attracted his attention. To prevent his wheel from having a jerking motion, he proposed to connect it with two or more pistons belonging to distinct cylinders, and so arranged, where there were two, for instance, that the one should descend while the other was rising and reciprocally. Two cylinders of atmospheric engines thus combined would produce exactly the effect of Watt's engines. The expense of steam would also be precisely the same. The idea of making a double acting engine by means of two distinct cylinders, was presented as new, in 1779, by Doctor Talck.

to the action of a constant force, it will, therefore, be accelerated in its motion towards either extremity of the cylinder in which it works, and this without producing any useful effect will tend to jar the whole apparatus. If, on the contrary, the valves adapted to the two tubes which establish the communication between the boiler and the cylinder do not remain open during the whole of the stroke of the piston; if they are closed for instance, in turn, when the piston has reached two thirds of the stroke, the remaining third will be accomplished by the momentum already acquired, and by the power which the steam already introduced will then continue to exert. This force will become less and less during this last third of the course of the piston, because the steam will gradually expand, and in proportion as it occupies a larger space, its elasticity, like that of every elastic fluid, will diminish. Thus, there will be no injurious rapidity of motion at the two extremities of the stroke, and, what is still more important, a smaller quantity of steam will be employed to produce the desired motion. Who does not see in fact, that, if the valve were open during the whole stroke of the piston, the condensation would destroy at every stroke a volume of steam equal to that of the cylinder, and of a density similar to that of the steam of the boiler, while that if the valve is closed when the piston is at two thirds of its stroke, one third less steam will enter and be consumed. Experiments have shown that in thus using a cut-off valve to regulate the quantity of steam admitted to the cylinder, a considerable quantity of fuel may be saved, while the same effect is produced; therefore they rank the specification which Watt inserted in relation to it in his first patent among the most brilliant of the inventions for which science is indebted to him; it does not appear, however, that in the greater part of the engines obtained from the manufactories of Soho, the cut-off principle has been employed to any considerable extent, but it has rather been resorted to to render the motion of the piston nearly uniform.

### *Jacket for the Cylinder.*

The *separate condenser*, the most beautiful of Watt's inventions, is intended, as we have already seen, to keep the cylinder constantly at the same temperature as that of the steam, so that it may not partially condense when it is admitted from the boiler. But the whole exterior surface of the cylinder is in contact with the atmosphere, and therefore continually exposed to its cooling action, and by the conducting power of the cylinder for heat, the steam must be exposed to this same cooling action. Watt proposed to diminish this effect by surrounding the cylinder with a second one. A casing of this kind, if closed above and below, would prevent the action of cooling draughts of air, and this alone would be an important advantage gained. But besides this, steam can be introduced into the annular space comprised between the two cylinders, and then the temperature of the cylinder proper will differ so little from that of the steam supplied by the boiler, that, practically, they may be considered as perfectly alike.

### *High Pressure Engines.*

The engines of which we have hitherto spoken do not require that the steam which sets them in motion should operate with a greater pressure than that of the atmosphere. To get rid of the steam after its action it is sufficient to condense it. This operation requires a copious supply of cold water, which in many situations is a serious inconvenience. Locomotive engines, such as will answer for drawing cars upon railroads, cannot be constructed upon this principle. They would, in fact, be required not only to carry

with them a sufficient quantity of fuel to supply the furnace, and water to replace that from the boiler, which is gradually converted into steam, but also an enormous quantity of cold water for the process of condensation. Such a machine would not be capable of doing much work; and would, in fact, be hardly powerful enough to impel itself. The necessity for avoiding the use of the condenser gives a high value to high pressure engines.

In these engines, when the steam has driven the piston upward, the opening of a valve allows it to escape into the air. The difference of elasticity regulates this escape; it ceases therefore as soon as the pressure of steam within ceases to exceed that of the atmosphere. Thus, there is not a vacuum in the cylinder, as in the condensing engine. The steam then, which, after the upward motion of the piston, is to drive it downwards, must overcome a resistance equal to the atmospheric pressure before it can produce any useful effect. The same remark applies to the ascending motion, for at the instant in which it takes place, the upper part of the cylinder contains steam, and thus in succession.

Papin first constructed an engine in which high pressure steam escaped after having produced its effect. This engine was exclusively designed for raising water. Leupold who made it known, described one of the same kind in 1724, in his *Theatrum machin. hydraul.* This had *a piston and working-beam*, but was single acting.

Finally,* in 1802, Messrs. Trevithick and Vivian, took out a patent in England, for a double acting high pressure engine, which has been applied by them, or others, to propelling carriages upon rail-roads. Watt, in his first patent of 1769, had already reserved to himself the right, in case cold water should be scarce, to make engines go entirely by means of steam, which might be allowed to pass off into the air after it had produced its effect; but it does not appear that any engine was ever constructed upon this principle in his manufactory.

### *High Pressure Condensing Engines.*

These are high pressure engines, in which the steam is condensed after it has acted, as in low pressure engines. The most esteemed engines of this kind are those suggested by Mr. Arthur Woolf, in 1804; but they cannot be applied to locomotive purposes. In the engines of this engineer, highly elastic steam coming directly from the boiler, passes into the cylinder as in a double acting engine. The steam is not, however, condensed as soon as it has propelled the piston to one extremity of its stroke. Mr. Woolf makes the most of it, before its condensation, in the following manner.

By the side of the first cylinder, there is another of nearly the same height, but of greater diameter. The upper part of the first communicates by a tube with the lower part of the second, and reciprocally. When the steam has propelled the piston of the first cylinder to the lower part of its

* The American reader will be surprised, and perhaps shocked, that an article on the high pressure steam engine should close without a mention of the name of Oliver Evans, who laboured so long to bring it into use, and died in poverty from the expenditures encountered in this his favorite object. In 1801, he had a high pressure engine at work in Philadelphia. His drawings were sent to England in 1794–5, and so nearly does the patented boiler of Trevithick resemble his, that the charge of plagiarism has been unhesitatingly preferred by American writers. But of all this, M. Arago appears to know nothing. A distant continent subtends a less angle to his mental vision than a near Island. Happily, as he says himself, the argument from Arithmetic is incontrovertible, and 1801 precedes 1802. TRANS.

stroke, at the precise moment in which the same piston begins to ascend by the action of a new supply of steam from the boiler, which impels it from *below upward*, all the steam with which the smaller cylinder is filled, and which has already given impulse to the first descending motion, flows into the second cylinder below its piston, and impels it also from *below upwards*. Thus, the two pistons move in the same direction. As soon as the motion is completed, the dilated steam which occupies the whole body of the larger cylinder passes into, and is condensed in a detached condenser. A new supply of steam coming from the boiler is then admitted *above* the first cylinder, and impels its piston from *above downwards*. The old steam with which the whole of the lower part of this cylinder was filled at the conclusion of the first motion, passes, and expands, *above* the piston of the second cylinder, and forces it *down*, so that the two pistons again work in the same direction. If each piston is provided with a vertical rod, and if the two rods are attached to two points of the working beam situated on the same side of its centre of rotation, the vibrations of the beam take place in virtue of the *united impulses of the two pistons;* the same steam therefore will have produced two effects before being condensed.

This engine of Woolf is a genuine expansive engine, resembling very much that described by Mr. Hornblower in his patent of 1781. It is not apparent *à priori*, why cutting off the steam should not produce, in the mode of working proposed by Watt, in a single cylinder, as much effect as in following Woolf's system.* The experiments published in the monthly reports of the mines of Cornwall, appear, it is true, very favourable to this system, but they will not receive a general assent until comparisons are made with engines alike in all other respects, save in the manner of using the steam expansively.

### *Steam Vessels.*

The application of the steam engine to navigation has, in certain countries, as in America for example, produced more important results than any other modern invention. The question of priority has therefore been the object of warm controversy. From the beginning the claims of France have been left out of the question, and the debate seems to have rested entirely between the English and the Americans. The latter attribute the application to Fulton. The English refer to the much earlier writings of Jonathan Hull and Patrick Miller. The argument is indisputably against Fulton;† but are there no works still older that Jonathan Hull's, and in which the ideas of this mechanician may be found already embodied? The reader will decide whether my researches upon this point have been unsuccessful. Jonathan Hull's work appeared in 1737. Here is the translation of the title, "Des-

* M. Arago appears to have overlooked here the effect of the cooling of the cylinder in which the expansion of the steam takes place in the common engine, requiring it to be again heated to the temperature of the steam in the boiler.—Trans.

† The argument is as decidedly against Fulton as against the claims advanced by M. Arago in favour of Papin, or Solomon de Caus, in relation to the application of steam as a motive power, in opposition to those of Hiero of Alexandria. The Americans claim for Fulton the first *successful* application of steam to navigation, and this cannot fairly be refused to him. A steamboat constructed under Fulton's directions plied regularly on the Hudson when there was no other steamboat running upon any other waters in the world. This fact cannot be impugned. The attempts made in France, England and Scotland, were *unsuccessful*, and the boats were subsequently laid up. Fulton's attempt succeeded, and since that time the application of steam to navigation has been steadily on the increase. The problem was solved.—Trans.

cription and draught of a newly invented machine for carrying vessels or ships out or into any harbour, port, or river, against wind or tide, or in a calm; on account of which his Majesty, George II, has granted letters patent for the profit of the author for fourteen years; by Jonathan Hull."

This work includes, in the first place, the figure and description of two paddle wheels placed at the stern of the vessel, which the author proposes to substitute for common oars; secondly, the proposition to turn the axis of these wheels by means of Newcomen's engine, then well known, but only used, according to Hull's own expression, to raise water by fire.

Patrick Miller's work appeared in Edinburgh in 1787, it contains also a description of paddle wheels,* considered as the means of propelling canal boats, and the notes of the author's experiments upon the most convenient method of making these wheels revolve. The last article concludes with the following remark: "I have some reasons to think that the power of the steam machine may be employed to turn wheels in a way to give them a quicker motion, and consequently to increase the speed of the boat."

Here is every thing of a precise character, or remote date, which the English critics have quoted in their controversy with their American opponents.† I shall now proceed to furnish my quota.

Papin's work which I have so frequently cited, the *Recueil* of 1695, comprises literally what follows, pages 57, 58, 59, and 60.

"It would be tedious to relate here in what manner this invention (that of the atmospheric engine) might be applied to draining mines, *to throwing bombs, to rowing against the wind.* . . . . I cannot, however, refrain from remarking how preferable this power would be, for ensuring speed at sea, to that of the galley slaves." Here follows his remarks upon living prime movers, which the author observes, occupy a great deal of room and are great consumers even when they are doing nothing. He observes that his tube (his cylinder) would be less inconvenient; "but as they could not," says he, "conveniently put ordinary oars in motion, it would be necessary to use revolving oars." Papin states that he had seen similar oars attached to an axeltree on board of one of Prince Rupert's vessels, which was worked by horses. His (Papin's) method of producing a rotary motion by the ordinary movement of the piston is as follows: "The rods connected with the piston should be indented in order to turn the little cog-wheels, fastened to the axles of the paddles." But as a piston does not exert any useful effort at the close of its downward course, in order to preserve the continuity of the rotary motion, he conceived the idea of employing a number of cylinders the pistons of which should operate in contrary directions, so that one should begin to descend as the other reached the termination of its downward stroke, etc. "But it will, perhaps, be objected," adds Papin, "that the racks of the pistons being caught in the teeth of wheels, would in rising and descending, give opposite motions to the axeltree, and that in this way the pistons which rose would hinder the motion of those which were descending; conversely, those which descended would hinder the action of those which ought to rise. But this objection is easily obviated; for it is quite a common thing for watchmakers to fasten toothed wheels upon

* These wheels had been used by the Romans to propel their galleys, hence any modern claim to the use is futile. See M. Arago's own admission on this head in a subsequent page.—TRANS.

† See the Quarterly Review for 1818, vol. XIX, p. 353 and 355. By this quotation it is plain that M. Arago is unacquainted with the American articles on this subject, and hence cannot be considered as authority in this case.—TRANS.

shafts or axles, in such a way that being impelled towards one side they necessarily cause the axle to turn with them, but towards the opposite side, they can turn freely without giving any motion to the axle, which may thus have a motion entirely opposite to that of the said wheels. The greatest difficulty then merely consists in erecting a manufactory for making tight tubes, thick and equal from one end to the other, etc."

Papin proposed then, in print, to propel ships by means of the steam engine, forty-two years before Jonathan Hull, who is looked upon as the inventor of steam navigation in England.*

The process explained by Papin for changing the rectilinear motion of the piston into a continuous rotary motion, is not inferior, I think, to that of the English machinist; for according to the latter, the wheels attached to the principal axis and the paddle wheels, only communicate with each other by cords.

The two cylinders, acting alternately, which Papin thought of making use of to regulate the motion of the wheels, are not so despicable as one might think them. Mr. Maudsley, one of the most able English constructors, has used them lately in many of his large boats to supply the place of the fly wheel, which cannot be used without great difficulty in a confined space.†

The substitution of a paddle wheel for ordinary oars, belongs neither to Papin nor to Hull; to say nothing of Prince Rupert's sloop cited by the former, we shall find in very old authors evident proofs of the employment of wheels. As to the first exact experiments upon which any judgment could be formed of the relative advantages of these two methods of impulsion, they can be hardly traced higher than the year 1699, and we are indebted for them to Mr. Quet,‡ (see. mach. appr. par l'acad, t. 1st.)

* What a step from the proposal to propel ships to its execution!—TRANS.

† The plan adopted long since by Mr. Stevens of two cranks at right angles connected with the same piston is much more eligible. But M. Arago seems not to have turned his attention to American mechanics or their devices, or to American writings on the subject of the steam engine.—TRANS.

‡ Mr. Robert Stuart's work (see page 83, 3d edition,) contains the following passage; "Jonathan Hull ought to be honorably mentioned for having pointed out paddle wheels, moved by a steam engine, as a means of propelling vessels without wind and sails. This proposition requires a change in the rectilinear and alternate motion of the rod of the piston into a rotary motion. Hull showed that a crank gave an ingenious solution of the problem. We now see rightly in this invention the origin of the introduction of the steam engine in the manufactories as impellents of every kind of mechanical operations." Thus, in the opinion of Mr. Stuart, Jonathan Hull has the double merit of having invented steam vessels, and of having shewn that the steam engine might be substituted for the mechanical agents hitherto employed in manufactories of every kind. I have but one objection to oppose to these conclusions; which is, that Papin's work, in which the idea of boats, and that of a continuous rotary motion communicated to a wheel by a steam pump, preceded the work of the engineer, Hull, by 42 years.

An English *Savant*, a friend of mine, to whom I communicated verbally the results contained in this memoir, told me that if I ever should publish it, he would confute all my assertions by passages taken from French authors. "It will be," added he laughing, "a war of quotations." Begging him to explain himself farther, I discovered that the arguments which he meant to array against me would be derived either from a biographical article upon Newcomen, from the pen of one of the most illustrious philosophers of our day, or in a memorial concerning steam vessels drawn up by the celebrated professor of mechanics in the Conservatory, and approved by the Academy of Sciences. In these two articles, I am compelled to admit, the opinions of English authors upon the inventors of the steam engine have been unreservedly adopted. The objection has therefore some weight, but it does not appear to me to be con-

In speaking of steam engines in general, I have endeavoured to give a share of the notice to the inventors, properly so called, and another to the engineers, who have been the first to turn the invention to account. If we continue to follow the same plan we shall find:

That M. Perier was the first, in 1775 to build a steam vessel, (a work of M. Ducrest, printed in 1777, contains the discussion of the experiments which this engineer witnessed; their date is therefore authentically verified);

That experiments on a larger scale were made in 1778, at Baume les Dames, by the Marquis de Jouffroy;

That in 1781, M. de Jouffroy, putting his plans into execution, actually established a large boat of the same kind, upon the Saône, which was not less than 46 metres long, with 4.5 metres beam.

That the minister of that time addressed the report of the favorable results given by this vessel, to the Academy of Sciences in 1783, with the view of deciding whether M. de Joffroy had a right to the exclusive privilege

clusive. As to what respects the memoir of Newcomen, I will remark in the first place that it is evidently copied from Robison's history; that the distinguished writer to whom we are indebted for it, no where announces that he has made particular research upon this occasion, or, that he has consulted original documents. If he had cited Solomon de Caus, I should have doubtless entertained scruples as to the importance which it appeared right to me to give to the researches of the French machinist; but his name is not found once in the biography, although, we find in large letters, those of Worcester and Savery. From this I think I may conclude with certainty, that the works of Solomon de Caus, and I presume those of Papin also, were unknown to my learned brother; (*confrère*)—his opinion ought not therefore to be opposed to mine, since I shall have the right, like an ancient Greek philosopher, to appeal from Philip to Philip better informed.* In reference to the second objection, I shall easily set aside the authority of the Academy of Sciences by remarking that its invariable rule is only to decide upon the *conclusions* of the reports presented to it. The developments, be they more or less extensive, which accompany these conclusions, do not give rise, on its part, to any deliberation, the reporter alone is responsible for them. Now the very minute report respecting steam vessels, which was read before the Academy on the 27th of January, 1823, winds up with *conclusions* in which I do not find a single word in relation to the inventors of the steam engine. The Academy has therefore decided nothing that can be brought in opposition to my views. As to the text of the report itself, I find in it, it is true, that the English were the first to employ steam power for raising water; that Worcester is the inventor, whose ideas Savery developed; that Jonathan Hull was the first who thought of propelling vessels by means of the steam engine, but as I neither see there the name of Solomon de Caus nor that of Papin, although, whether for good or evil, they were occupied with these same questions before the English mechanicians, I may claim the right to reproduce here the reflections which the article in the Universal Biography suggested to me some time ago. Besides, the authorities, however respectable, are in this place of no importance. The question is reduced to the simple point, whether the works by which I have supported my argument really bear the date assigned to them, and whether my extracts are faithfully made. Though all the Academies in the world should decide, by common consent, that Worcester first conceived the idea of impelling water by the elastic power of steam, it would not be less an established fact that the idea belonged to Solomon de Caus, since 1615 preceded 1663. As long as it has not been proved, in like manner, that the year 1695 followed 1736, Papin, in spite of all reports past, present, and to come, will have the merit of having proposed steam vessels 42 years before his competitor Jonathan Hull.

* For the same reason on the subject of the high pressure engine, and of the Steam Boat, we appeal from M. Arago to M. Arago better informed.

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which he claimed,* (Messrs. Borda and Perier, were appointed a committee on it);

That the trials made in England by Mr. Miller, Lord Stanhope and Mr. Symington are of a much later date, (the first should be referred to the year 1791; Lord Stanhope's, to 1795, and the experiment made by Symington in a canal in Scotland, to the year 1801);

Lastly, that the attempts of Messrs. Livingston and Fulton at Paris, not taking place until 1803, could with so much the less propriety give title to the invention, in that Fulton had had a minute acquaintance in England with the experiments of Messrs. Miller and Symington, and because many of his countrymen, Mr. Fitch, among others, had devoted themselves to the subject by public experiments from the year 1786.† Let it be observed, however, that the first steam vessel, which was not given up after being tried; the first which was applied to the transportation of men and merchandize, was that which Fulton constructed at New York, in 1807, and which made a trip from that city to Albany. In England the first steam vessel established for the convenience of commerce and travellers, dates as far back only as 1812; it navigated the Clyde, and was called the Comet. The second began to run in 1813; it made trips between Yarmouth and Norwich.

### *Contrivances which render the Steam Engine self-acting.*

The first of Newcomen's engines required the constant attention of a workman who opened and closed, alternately, various valves, sometimes to let steam into the cylinder, and sometimes to admit the water required to condense it. Tradition attributes the first invention of the contrivance, by means of which the engine itself opens the valves at the proper time, to a boy named Humphrey Potter. It is said that Potter, disconcerted one day at not being able to go and play with his companions, took it into his head to tie the ends of a piece of pack-thread to the handles of the two cocks which he was stationed to open and shut; the other ends being fastened to the working beam, the pull which it occasioned in rising or descending, did the office which had been performed by hand. Beighton, the engineer, improved very much upon this idea, by fixing a bar of wood called a plug-frame, vertically, to the working frame. This bar was provided with various plugs, which bore upon the stems of the different valves, at convenient times determined by the vibration of the beam. Beighton's mechanism was adopted by Watt with some advantageous modifications. The distribution of steam into the various parts of the cylinder, is now effected by simpler means which have entirely superceded the use of the *plug-frame*, at least in engines in which the power is not excessively great, and which are intended to communicate a rotary motion. This contrivance, which I will not here attempt to describe, as without drawings it would perhaps be unintelligible, is called an eccentric. An eccentric wheel attached to an axis turned by the engine, gives two opposite motions to the slide, during each of its revolutions; these two motions suffice to admit the steam from the boiler above and below the piston suc-

* The vessel tried at Lyons, contained two distinct steam engines. The events of the French revolution compelled M. de Jouffroy to emigrate, and all his efforts were consequently without result.

† Rumsey's name is not even mentioned by M. Arago, nor is he acquainted with the claims of Stevens, Evans, and others. It is highly desirable that some one acquainted fully with this subject would take up the assertion of our countryman's claims against the manifest injustice here and elsewhere done to them. The tardy admission made in the next sentence is not justice. TRANS.

cessively, and to provide a convenient outlet towards the condenser for that which has already acted.

The mechanism of the slide and its eccentric, was contrived by Mr. Murray, of Leeds, in 1801.

In high pressure and double acting engines the steam is let in successively above and below the piston, and as soon as it has produced its effect is let off into the air. All this only requires a quarter of a turn of one and the same cock, called the four way cock. This very ingenious apparatus is uniformly employed at present in all the large water-engines made in Germany. Its invention belongs to Papin: it may be seen in the high pressure engine of this machinist, a figure of which is given by Leopold, and in that which Leopold himself subsequently proposed, in the year 1724.

### *The Crank and Fly Wheel.*

Mr. Keane Fitzgerald published in the Philosophical Transactions, for 1758, p. 727, *et seq.*, the description of a process for transforming the rectilinear motion of the piston of a steam engine into a continuous rotary motion. For this purpose he made use of a rather complicated system of toothed wheels, several of which were ratchet-wheels. Thus far the method of this engineer agrees with that of Papin; but he improved upon it by adding to this mechanism, a *fly-wheel*, a valuable contrivance for regulating the motion of steam engines, now in general use, and the honour of which justly belongs to Mr. Keane Fitzgerald.

While the oscillating motion of the working beam of a steam engine was transmitted to the revolving axis by the intervention of toothed-wheels, it was exposed to fractures, very vexatious in themselves, and the more so on account of the interruptions of work which they occasioned. In 1778 Mr. Washborough of Bristol, proposed to make this communication by means of a crank connected with the revolving axis. This, it will be perceived, was simply to make use of an expedient found in all spinning wheels, and in the apparatus of every knife grinder.

Nevertheless a patent having been taken out, a contrivance which every body was at liberty to make use of when the motive power was either the foot of a man or a current of water, was interdicted to the engineer whose engine operated by steam. In order to avoid the tax which he would have been obliged to pay to Mr. Washborough for each one of his engines, Watt made use of a communication of motion slightly different, until the expiration of the patent right which the former possessed; this operated by means of a toothed-wheel fastened to the revolving axis, which he called the *sun wheel*, because its centre remained fixed, and another wheel also furnished with cogs attached to a rod from the working beam, and which, as it revolves round the other wheel, he called the *planet wheel*. It would be of no use to describe this piece of mechanism more particularly, since Watt himself used the crank as soon as he could.

### *The Parallel Motion.*

In Newcomen's or Watt's single acting engine, the working beam terminated in the arc of a circle, and a flexible chain, attached to the upper extremity of that arc was the means of communicating between these two parts of the apparatus. When the piston descended by the pressure of the atmosphere, it *pulled* the beam. When the beam rose again by the action of a counterpoise placed at the opposite extremity, it *pulled* the piston. Now

though a chain, however flexible it may be, is always excellent for a pull, it will not answer to push, and hence the double acting engine requires a different connection. In the descending motion of the piston it draws the beam; but in the succeeding motion, or when the beam rests again, it ought to be *propelled* from below upwards: which the chain cannot do. The first contrivance, therefore, required modification.

The first modification adopted consisted in cogging a part of the rod of the piston, to make a rack of it, which caught in a circular arc, also cogged, and fixed to the extremity of the working beam. This is what Papin proposed in 1695.

Subsequently, Watt devised a much preferable method, which is now generally adopted wherever there is no want of room; it is called the *parallel motion*. It would be very difficult for me to give a complete description of it here, without figures. Suffice it to say that a parallelogram the four angles of which have four pivots, and which consequently may assume all sorts of angles without ceasing to be a parallelogram, is attached by its two upper angles to the working frame of the engine; that the piston rod is fixed to one of the lower angles, and that the fourth angle is fastened to a stiff radius rod, movable round a fixed centre. Whatever the position of this centre, if the lever attached to it remain of invariable length, the parallelogram changes its shape during the vibrations of the beam, being sometimes a rectangle and sometimes a rhomboid. But when the centre to which the lever is attached is suitably chosen (herein the discovery of Watt consists) the angle of the movable parallelogram of variable form, *to which the piston rod is attached*, does not sensibly depart from the vertical during the vibration of the working frame. The motion of the piston is in this manner perfectly regulated and its communication with the working beam taking place by the intervention of an inflexible system, it can with the same ease *draw* the beam downwards during the descending motion of the piston as *force* it upward when the piston rises. The jointed parallelogram attracts the strongest attention from persons who witness the operation of a steam engine for the first time. To the eyes of the practised machinist, it presents itself as an apparatus of easy construction, entirely exempt from concussion, and susceptable of indefinite duration. It is evidently one of Watt's most ingenious inventions. The patent in which it is described is dated in the month of April, 1784.

### *The Governor.*

The pipe which, in Watt's engines, lets the steam from the boiler into the cylinder, contains a thin plate, or valve, similar to the dampers which are fitted in our stove pipes. In a certain position, the plate leaves the opening of the pipe almost entirely free; in another it is entirely closed, and in the intermediate positions of the valve, the opening is greater or less according to its approach to the two limits just mentioned. The valve may be moved by a handle attached to the axis which is prolonged to the outside of the pipe.

If the valve is entirely open the steam fills the cylinder very rapidly; if it is nearly closed, it requires, on the contrary, a considerable time to effect the efflux of the same same quantity of steam. Now the number of seconds occupied by the strokes of the piston depends evidently upon the rapidity of the pressure of the steam upon one or other of its surfaces. The turning valve in the tube gives, therefore, in a certain degree, the means of regulating this rapidity.

If the axis of the valve terminates on the outside of the pipe in an elbow so as to form a crank, the strokes of the piston can be accelerated or retarded by turning this crank in one direction or the other. Suppose, for instance, that the crank must rise if the piston moves too fast, and should be retarded; and that it should descend, on the contrary, when the piston goes too slowly. By fitting a piece to the engine which must necessarily rise when the working is accellerated, and necessarily descend as soon as it is slackened, the problem would be solved, for it is only necessary to connect this piece in some way or other with the handle or crank of the valve. Such is the object of the contrivance which Watt called the *governor*. This apparatus is composed of an upright spindle which the engine turns more or less rapidly according to its own rate of working. Upon the upper end of this axis is fitted a horizontal pivot, to which two metallic rods are suspended by joints working freely, so that they may fly off, more or less, from the vertical. Each rod has a large metallic ball at the end. When the vertical axis is set in motion by the engine, the balls which turn with it fly apart to a certain limit, by the action of their centrifugal force. If the action of the piston becomes more rapid the balls fly farther apart, or approach nearer to each other in the opposite circumstances. In the first case the balls rise, and in the second descend. These rising and falling oscillations are communicated by levers to the handle of the revolving valve of the tube which supplies the steam, and any considerable alternation in the speed of the engine is in this way obviated. This apparatus, composed of movable rods with balls, this conical pendulum, as it was formerly called, had been long used as a regulator on the flour mills. It was also used to regulate the opening of flood gates of streams employed in setting overshot wheels in motion. This last application was precisely like, both as regards the end and the means, to that which Watt made of it, in adapting it to the steam engine, in the year 1784.

[TO BE CONTINUED.]

## Civil Engineering.

*Description of Black Rock Tunnel, on the Philadelphia and Reading Railway.* By W. H. WILSON, *Civil Engineer.*

Black Rock Tunnel on the line of the Philadelphia and Reading Railway, is 1932 feet in length, 19 feet in width, and $17\frac{2}{10}$ feet in height. The form of the roof is a semi-ellipse of 19 feet base, and $6\frac{3}{10}$ feet height; the sides are perpendicular for five feet down, and then curved so as to give a width of $17\frac{7}{10}$ feet at bottom, or 18 feet on a level with the top of iron rail, which is 10 inches above the bottom. The floor is level throughout, and the area of the cross section is $301\frac{5}{10}$ square feet.

This tunnel was adopted to avoid the necessity of following a bend of the Schuylkill river, by which the distance would have been increased upwards of a mile and a half, and several abrupt curves made necessary. In order to facilitate the excavation, and afford a proper ventilation, six shafts were commenced, to be used both as working and air shafts; one of these was abandoned at the depth of 28 feet, in consequence of great interruption from water; the remaining five were excavated to the required depths. The depths to bottom of tunnel, are as follows: $116\frac{6}{10}$ ft., $139\frac{4}{10}$ ft., $138\frac{7}{10}$ ft., $100\frac{8}{10}$ ft., and $82\frac{1}{10}$ ft., and the diameter of each is seven feet. Instead of

being placed, as usual, over the centre of the tunnel, the shafts were located on one side, by which arrangement the difficulty of giving the proper direction for mining was somewhat increased, but the danger to workmen below from the accidental falling of bodies in the shafts considerably lessened.

The shafts were arranged in pairs (100 feet between each two) for the purpose of affording greater certainty in obtaining and preserving the proper direction of tunnel. The short space between two adjacent shafts being excavated first, two correct points were obtained in the centre line of tunnel, 100 feet apart, from the range of which the long drifts could be worked with accuracy. At first one gin was used for every two shafts, the bucket in each being alternately up and down, but as by this plan the material could not be taken away as fast as it was excavated, it became necessary to erect a separate gin for each shaft.

While sinking the shafts, common windlasses were used, worked by men, but when the drifts were commenced, the gins were put in operation. Each gin had two buckets attached to it, and was worked by two horses. The depth of open cutting at the North end of the tunnel is 47 feet, and at the South end $54\frac{5}{10}$ feet; the material as well as that removed from the tunnel and shafts was a very hard silicious slate rock. In sinking the shafts, it was found that but two men could work to advantage at the same time, one with a hammer, the other with a drill; this kind of work, laborious at any time, was made more so in this instance by the extreme wetness of the shafts, in consequence of which the tour of duty was limited to eight hours out of twenty-four, and in one of the shafts, for a short time, to six. At the top of each shaft two labourers were required to work the windlass and empty the buckets; these men were changed every twelve hours. The excavation of the tunnel was driven from both ends and from the five shafts, the area of the cross section being divided into two parts, of which the upper, comprising the arch, or roof, was excavated first, except in some few cases, where the peculiar stratification of the rock obliged the workmen to change their usual direction. At each end of the tunnel two separate bodies of workmen were constantly employed, one at the heading and the other some thirty or forty feet behind, completing the excavation to the full size.

In the drifts connected with the shafts, but one set of men could be worked to advantage, on account of the great difficulty in getting away the material. A set of men for one heading generally consisted of one superintendent and fourteen Miners, working seven drills; in addition to which, from two to five labourers were required to remove the material excavated. The time of labour was from six to six o'clock, deducting one hour at noon and at midnight, for meals, so that each man worked eleven hours out of twenty-four. Temporary railways were laid in each drift, upon which small cars with low wheels were used; the cars at the ends of the tunnel were larger than those in the other drifts, and so constructed as to tilt their burthens. At the shafts a bucket with a false bottom, secured by a hinge and bolt, was placed upon the car, then filled and rolled to the foot of the shaft, where it was attached to the rope; at the top, the bucket was hoisted sufficiently above the ground to admit of a car being run under it, when the bolt was knocked out, and the material fell into the car by which it was conveyed away.

The buckets used were two and a quarter feet in depth, two feet six inches in diameter at bottom, and two feet two inches at top, holding about nine cubic feet; those for raising water were about the same size, but made in a neater manner, with a valve in the bottom for letting off the water.

The ropes used were one inch and a half in diameter, and passed around the large drum of the gin a sufficient number of times to prevent slipping; at each end was attached a hook with a spring to keep the bucket from getting off accidentally, and the length was such that one end would be at the top of the shaft while the other was at the bottom, From the time the shafts attained a depth of about 70 feet until the drifts leading from them became connected with each other, it was necessary to use some artificial mode of ventilation. Several different plans were tried, but the following was the most effectual; a wooden pipe about four inches square was secured to the side of the shaft by irons driven into the rock, and was attached at the upper end to a fanning machine; the wooden pipe was not allowed to reach quite to the spot where the miners were at work, as it would have been liable to injury from blasting, but the deficiency in length was supplied by a bag or pipe of canvass, which could easily be moved when necessary. The partial use of this machine was sufficient to supply a proper quantity of fresh air. This work, including the deep cuts at each end, and about seventeen hundred feet in length of grading adjacent to the south end, was contracted for by Mr. James Appleton on the 21st of October, 1835. In December the excavation of the shafts and deep cuts was commenced. On the 8th of March, 1836, tunnelling began at the North end, and in the course of the ensuing summer, drifts were successively started from the other points. The work was prosecuted night and day with very little intermission until completed; the number of men employed amounted at one period to about 450. The last junction of drifts was effected on July 7, 1837, and the excavation completed the same year. In July, 1838, the track on this division of the Railway was opened for public use. About 670 feet in length of the tunnel (heading) were worked from the ends, the remainder 1262 feet being excavated from the shafts. The following tables exhibit the progess made in excavating.

*Sinking Shafts.*

| | No. of days. | No. of nights. | Spaces of 12 hours each. | Depth excavated in feet. | Average depth excavated every 12 hours |
|---|---|---|---|---|---|
| | | | | | Feet. |
| Shaft No. 1 | 177 | 151 | 328 | $101\frac{5}{10}$ | 0.31 |
| " " 2 | 38 | 18 | 56 | 28 | 0.50 |
| " " 3 | 214 | 166 | 380 | $125\frac{4}{10}$ | 0.33 |
| " " 4 | 245 | 202 | 447 | $126\frac{8}{10}$ | 0.28 |
| " " 5 | 173 | 120 | 293 | $93\frac{1}{10}$ | 0.32 |
| " " 6 | 128 | 85 | 213 | $70\frac{6}{10}$ | 0.33 |
| | 975 | 742 | 1717 | $545\frac{5}{10}$ | 0.317 |

*Heading of Tunnel.*

| | No. of days | No. of nights. | Spaces of 12 hours each. | Length excavated in feet. | Average length excavated every 12 hours. |
|---|---|---|---|---|---|
| | | | | | Feet. |
| North end | 312 | 247 | 559 | 522 | 0.93 |
| South end | 156 | 138 | 294 | 185 | 0.63 |
| From Shaft No. 1 | 66 | 67 | 133 | $86\frac{6}{10}$ | 0.65 |
| " " 3 | 156 | 156 | 312 | 236 | 0.75 |
| " " 4 | 131 | 131 | 262 | 113 | 0.43 |
| " " 5 | 245 | 235 | 480 | 316 | 0.66 |
| " " 6 | 177 | 170 | 347 | 224 | 0.65 |
| | 1243 | 1144 | 2387 | $1682\frac{5}{10}$ | 0.705 |

In the above tables, the second and third columns show the number of days and nights occupied in excavating the depth or length specified in the fifth column; the fourth column is an addition of the days and nights, showing the number of spaces of twelve hours each. It will be observed that the total of the fifth column in each table, does not correspond with the amount of work of the kind belonging to the tunnel; the balances not specified, were done at irregular times or with irregular forces, and would not consequently give a correct average. The following is the total cost of the tunnel and end cuttings:

| | | | | |
|---|---|---|---|---|
| Excavation of tunnel | 21713 cubic yds. at | 5.80 | $125,935 | 40 |
| " shafts | 881 " | " 20.00 | 17,620 | 00 |
| " open cuttings | 22126 " | " 1.00 | 22,126 | 00 |
| Masonry of façades | | | 2,832 | 00 |
| Incidental work, | | | 3,239 | 00 |
| | | | $171,752 | 40 |

The above includes work done and materials furnished of every description, no extra allowance being made for bailing water, use of machinery or any thing else. Among the items of expense incurred by the contractor, as stated by him are $6680 for powder, and $4372 for candles. The rock through which the tunnel is excavated is sufficiently solid to render unnecessary any support to the sides and roof, a cut stone façade at each end being all the masonry required. The hill at the north end of the tunnel rises very abruptly from the Schuylkill river, which is crossed by a neat stone bridge of four spans, situated on the same straight line with the tunnel. During the progress of the work several veins or seams were met with, containing calcareous spar, intermixed with sulphurets of iron and zinc, from which many beautiful specimens were taken. It was a source of much satisfaction to all concerned, that the junctions of the several drifts were effected without accident, and that the levels and lines of direction coincided exactly throughout the whole length. The above description has been compiled from a diary kept by the writer, who had the immediate management of the work, under the direction of Messrs. Moncure and Wirt Robinson, principal engineers of the Philadelphia and Reading Railway Company.

*Eighth report of F. R. Hassler, as superintendent of the survey of the coast of the United States, and of the construction of standards of weights and measures; rendering account of the works of* 1839.*

*Upon the survey of the coast.*

1. The proper organization and course of operation in a geodical work of such extent as the survey of the coast of the United States, is dictated by the nature of the country, and the relative position of its parts; presenting a long stretch of very unequal coast, with only such a breadth as the exigences of the work required; this dictated to begin at such an approximately central part of the country as would present the most facility and best prospects for large triangles, to serve as foundation of the work, and produce the greatest quantity of data for that purpose in the shortest time; presenting, also, within its limits, a locality for a base line of proportional length, and the necessary facility for its accurate measurement, from which the work might afterward spread in both directions of the country simultaneously, and alternately, as circumstances would dictate or allow.

2. Thence the work was begun in the neighborhood of New York Sound, Long Island, and its large sound, &c., which evidently present the requisites and qualifications above stated. The works of the preceding years had filled up with the main and secondary triangulation, and the topographical, as well as hydrographical detail, most part of the district from the Jersey shore of the Raritan and New York bay, till towards the east end of Long Island, the Sound, and opposite islands, the shore of the main land of New York, Connecticut, till Black Point, &c.

3. The field works of this last season were in some measure a beginning of the stepping over from the eastern side of these works to the southwestern, to open on that side, also, the field for the topographical and hydrographical detail works through the southern parts of New Jersey, part of Pennsylvania, to the seashore of Jersey, along Barnegat bay, and the Delaware.

4. All the survey of Long Island, as well the topographical, as the hydrographical part of its outer seashore on the south, and that of the sound to the north, had been completed the preceding years, till to Gardner's bay, of which a part of the sounding remained yet for this year.

5. The works of this year on the northern shore of the sound, include, as well the topographical, as the hydrographical surveys of Block island, the numerous islands of Fisher's sound, and others, the shore of Connecticut, and Rhode Island, with their deep inland waters, from Black point, where the hydrographical works had ended last year, through the whole of Fisher's sound, so that the work reaches now on that side of the shores and waters of the eastern States.

6. The surveys on land were carried inland as far as the nature of the coast on one side, and the time on the other, dictated or allowed; always furnishing, to the hydrographical party, which is carried on parallel with the works on the shore, the fundamental points to ground their determinations of the points of sounding upon them: these works occupied one of the sounding parties, and a number of topographical parties.

7. The other sounding party finished the works in Gardner's bay, thence

* From Congressional Documents, 26th Congress—1st Session—read to the Senate December 27th, 1839.

round Block island, along the shores of the row of islands, turning up to the main, and a part of the main shore, in continuance of where the other party left off, from the side of Fisher's sound; a part of the same topographical parties furnishing the determining land points as always usual.

8. A second part of the work to be executed this year, in that eastern part of the survey, was the topography of the parts, between the country near the shore, surveyed with reference to the sounding more especially, and the limit of the main triangulation, farther in the interior; the former having always been accelerated in its progress, so as to assist constantly the hydrographers in their progress on the water, it could not be carried sufficiently deep, land inward, for all the wants of the survey in general, this part of the topographical works was therefore to be completed, and it required yet some secondary triangles to complete it, besides the plain table works. It appears, however, that the season will not serve long enough to prevent operation if it fall yet in next year's work. But this will not prevent the house works of mapping, which are intended to be done the coming winter for that part of the country.

9. A work similar to the above, but of much smaller extent, was executed on the west side of the New York and Raritan bay through the county from the North river near the sloat on the west side of the Hudson river, corresponding opposite to Tarrytown, on the east side of it, which is the boundary point from which the work, which has just been mentioned, starts towards the east.

The western limit of this work following the Newark mountains, and the triangle points established upon them, until to their intersection with the Raritan river behind New Brunswick, and to the parts surveyed as shore line in that part of the country.

10. Thus the survey of the whole country from the New Jersey shore of the Raritan bay, Sandy Hook, and Shrewsbury, till to the waters of the eastern States is completed in topography and hydrography, grounded upon and included in, a great number of secondary triangles, which themselves are based upon the main triangulation.

Only over a small portion, at the east end, the primary triangulation does not yet reach, but the secondary triangulation is accurate enough, and near enough to the main triangles upon which they are grounded, to secure against all doubts upon sufficient accuracy for the detail operations of topography and hydrography. When the main triangulation will be again carried to that side of the work, it will soon cover it over. The whole of the works presents to the south in some measure a straight line, from which the work will proceed southerly through New Jersey and Pennsylvania.

11. Views for the guidance of the navigator approaching the shore as mentioned in the last report, have been made last summer by one of the assistants, on the whole extent of the outside coast of Long Island, and at such places of the eastern part of the sound, as were found properly the hydrographic parties, who had of course to lead the selection of these points; these are of two kinds, the one guiding, the others warning. The first are aspects of the shore from the most important points of a channel or entrance of a port, &c., by which the seaman is guided in his proper course in approaching. The second kinds are views taken from rocks, shoals, or other dangerous places in the approaches of the shore, which the view given shall warn him to avoid.

12. In extension of these principles, the views of every light-house were taken double, first from the habitual ship channel at a distance at which

vessels would habitually pass it, and second from the proximity, where the light-house becomes entirely visible, and so near as to warn from nearer approaching unless special views of landing, &c.

The south shore of Long Island is well known for its dangers by the multiplicity of shipwrecks on it; therefore, special direction was given to draw views from the habitual ship channel outside, at every short interval, or in some kind of a moving panorama, by which the approaching seaman may reconnoitre the part to which he is near, and guide himself in his course by the views which he is thus shown that he shall meet in succession in his intended course.

13. From Sandy Hook southerly, the Jersey seashore, with Barnegat bay, and a certain breadth along the inner shore of the same, has also been surveyed, till down to the neighbourhood of Egg Harbour river. This part of the shore is difficult of access, from the interior by triangulation, on account of the heavy wooded, but low hills which separate it from the other land of Jersey, so that it will become unavoidable to cut through the forests in various places, to get lines for triangles, joining this work to the interior parts in several places, in order to bind up with accuracy the long series of small operations, necessitated by the peculiar difficulties presented by the nature of the locality. The hydrographical part of the same locality was also intended to be begun, but as it could not be attended to this year, it will form the first work for sounding vessels next spring.

14. The extension of the secondary triangulation over New Jersey, between the Raritan bay, the Delaware and the seashore, for which the accurate first elements are given by the main triangulation, carried entirely to the same extent; and from the southern line, stated above, for all other works, was carried in advance of the main triangulation the most favourable points. This same operation has been continued this year more southerly, so as to lay out triangles for further extension westerly, to join the head of the Chesapeake, including in its course the northern monuments of the so called Mason and Dixon's line.

15. It is well known that the meridional parts of this Mason and Dixon's line has been applied to conclude upon the length of a degree of the meridian in that country and latitude, and that the result has been used, in former times, by European mathematicians, in their comparisons with the other measurements of degrees in different parts of the world, but gave so unsatisfactory results as to be always rejected. It will, therefore, be of interest in the course of the present survey, if ever possible to verify the meridional distance, by means of the triangulation for the coast survey, and the latitudes of the two end points, either by the same, or by new astronomical observations.

16. The scientific account of the operation being recorded in the transactions of the London Philosophical Society, that part can be easily verified. But the monuments placed on the ground may, or may not, be found again in the old places, with the necessary accuracy to warrant proper confidence. In the archives of the State of Maryland such documents exist as may give a clew to designate the localities of them. Therefore there have been already some researches made upon the subject, and the verbal accounts of the persons living in the neighborhood may fully lead and decide upon the application of the diplomatic documents, that will be found to the locality when compared upon the spot. Whatever may be the result, this investigation is of scientific interest, and can, therefore, not be passed over

uninquired or unverified in a work like the coast survey, passing over the same ground.

17. From some proper points below Philadelphia, there will be a branch of the triangulation carried on easterly towards the sea, to join the topographical works made along the seashore, Barnegat bay, &c., as stated above, and also southerly to Cape May and Cape Henlopen, at which point it will be proper to join again both these two series of triangles.

18. The place of Cape Henlopen light-house must form a point of the main triangulation, though lying somewhat out of its shortest course, to bind up and compare with all accuracy, the results of the latitude and longitude determinations, made there on the occasion of the passage of Venus over the sun in 1769; which is another scientific work, executed in that neighbourhood in the last century, and a more interesting one than the preceding, it being generally considered as more accurately executed.

19. This summer the main triangulation has been carried on through Jersey, from the triangle points lying in the district of the works first enumerated, southerly to the neighbourhood of Philadelphia; how far it may be possible to continue it south of it, must of course, depend upon the weather, which at this time of the year is very uncertain. Over all this district the secondary triangulation must necessarily next year be carried more into details, and the topographical parties will also begin operations in it.

20. The main triangulation having been begun earlier this year than the former, more stations of it have been executed, and it will be brought as soon as possible, in following years, to the head of the Chesapeake bay; the part of the country thereby obtained will then present again a systematic mass of work, connected so as to form the elements of another series of maps and data for publication, similar to the works now executed and above enumerated.

21. The results of the whole work in triangulation, topography, and hydrography, as far as obtained, the end of last year, were last spring collected together in one map, upon the scale of $\frac{1}{100000}$, as already noticed in my last report as begun; every separate sheet of work is there numbered, as it is in the register of the works, and its limits marked, so that any execution of maps, within the limits of the work, can be guided by this preliminary in some measure tangible register of the works; the same system is, of course, to be pursued in future.

22. It will be a special question to decide in each case of executing any map from the coast survey works, upon what scale it shall be executed, according to the different aims and purposes; this register map will in all cases give the means to form appropriate plans upon that subject, calculate the size and position of the whole map of the sheets, or any part of them.

23. During the coming winter the assistants will again be occupied as in the preceding ones, only the calculations being of a somewhat different nature, principally relating to the systematic junction into one body, of the results of the trigonometric operations that have been executed; all the calculations are always to be made three-fold; being now numerous, much of the time of the assistants will be used in it, and as well this as the reduction of some of the works to ultimate maps for final execution, will occasion to keep some of the assistants engaged in this work, instead of in the field work.

This arrangement is well appropriated to the work in its present stage, and, at the same time, agrees with the state of the balance remaining from

the last appropriation, as it will postpone some of the expenses of the field equipments.

24. This will make ready for any final execution for drawing, &c., the whole extent of the coast and country adjacent, from the New Jersey shore to the end of Rhode Island shore, in the topographical and in the hydrographical parts.

This part of the coast, forming, in some measure, a whole work by itself, containing about three thousand square miles, will therefore be taken in hand immediately, for final execution upon two different scales, for the different purposes, to which they must naturally serve in future.

25. The map of the bay and port of New York, which has been especially mentioned last winter, as desired to be published, forms an essential part of this work, and will, of course, be attended to the first, with this view, for which arrangements are in progress.

26. A provision of the best quality of large drawing paper, appropriated to our work from the manufactory of Aunounay has just been announced as having arrived in New York for our use.

27. With the view to prepare for engraving maps, copperplates have been ordered in Vienna from Hungarian copper, on account of its best quality: these have just been announced as being under preparation, and that they may be expected in a few months: they will, therefore, certainly arrive before actual use will press for them.

28. In respect to the appropriation for the coast survey, to be proposed to Congress at the next session, I have only to state that it will be most economical for the best progress of the work, that Congress would please to appropriate $100,000, as I had taken the liberty to propose last year, because it will be necessary to begin incurring special and new expenses, for the arrangements and provisions required for executing final drawings, and begin to engrave. If the final appearance of the maps, when published, shall do justice to the trouble and expense incurred in the survey, the whole must come out of one systematic establishment, from which nothing should go out without the stamp of the establishment.

29. It is not proper, nor in fact possible, to separate these works from the drawings consequent upon the coast survey generally, because the works naturally interlock in one another, so that no distinct account can be kept, nor the works be detached from the assistants, who have worked at them in their origin; there should, therefore, be applied for the final drawing the necessary preliminary expenses of different kind of engravings, &c., such moneys of the appropriation total as may be needed, and the whole will enter into one mass of expenditure, like it is one system and map of work.

30. Except these establishments, and the expenses which must naturally be incurred in consequence thereof, there will be no change in the assistants employed, and the general arrangements and organization of the work, so that it is expected the diminution of some of the field expenses, as mentioned above, will about cover the additions which the last two sections show as necessarily to be added in the present state of the work: this presents a stepping over towards its full fruition at an epoch of its age, shorter than I believe can be shown in other similar work.

*Upon the construction of the standards of weight and measures.*

1. Since my last report upon these works, the full sets of weights for all the custom houses have been delivered and distributed according to their destination.

2. Weights had been prepared to become, when standarded, the heavy ounce weights for the mints, to be grounded upon the sets of ounce weights, till to the one hundred ounce weight, which were delivered to the mint in Philadelphia, early in 1838, as has been reported upon in proper time.

The mint having, in the meantime, constructed more accurate balances, desired for the sake of acceleration, to receive these weights in that unfinished state, and adjust them in their own establishment. This being granted by the Treasury Department, the whole of the sets, with their packing boxes, &c., complete, were delivered to the director of the mint at Philadelphia, and also the beam of an unfinished brass balance, of large size, which had been begun, and which they were in need of, to assist in the adjustment of the weights delivered.

3. The principal attention in the way of adjustment of standards this year, was put upon the numerous yards ready for it, a task which it is impossible to make hasty, and which requires in all cases continued and very fatiguing application; many thousands of microscopic observations are required for it. The specialities of these minuted parts of the work belong rather to an ultimate full account of all the means and methods employed in the execution of the whole task of the establishment of the standards which it will then be proper to publish, and distribute on Government account, like a similar account of the works of Mr. Bessel, of Konigsberg, for the establishment of a standard length measure, has been published lately by the Government of Prussia.

4. The feeling lever apparatus, which Professor Bessel has directed to be made for this establishment, at Berlin, he has lately announced to me as being nearly ready, so that it may perhaps yet arrive before the final delivery of the yards. This would afford the opportunity of establishing some comparisons by two methods, by the microscopes, and by the lever, which would be the more desirable, as the latter is intended to remain in the establishment for future use in comparisons.

5. A number of yards sufficient to furnish all the States are ready; but it is not proper to deliver them as yet, as it will tend to more accurate coincidence, to combine more numerous comparisons, under a variety of temperatures, and with different means. Besides the original standard scale of eighty-two inches, described in the report, upon the comparison of the weights and measures of the custom-houses, various other sets of microscopic arrangements were constructed, and constantly employed, whereby always a number of comparisons are carried on at the same time.

6. The form of the yards is that which has been formerly already mentioned, as best adapted for the preservation of their accuracy; the yards being cut to a length, in about the half breadth of a strong brass bar, and fitting between the butting pieces at both ends of a similar bar of equal thickness, which it fills exactly, so that when joined they form one piece, and nothing can ever touch the ends, which determine the exact length; this arrangement presents evidently two different means of ascertaining the length of the yard to the nicest; but it should be used only when it is desired to give the length of other yards that are intended *to form again standards.* For the transfer of the yard for common purposes, there is a special decimally divided length of a yard traced upon the outer piece of the yard, or matrix, between two parallel lines. A tracing arrangement is given with it, by which means, the yard being left undisturbed in its proper place, in the box fitted for it, a bar of metal, or wood, for which a location is made parallel to the yard, can be laid off and subdivided, without in any way injuring the

original; the use of this will be described in a statement to be added, as instructions at the delivery of the yards. My assistant worked at a considerable number of these divisions, until interrupted by sickness.

7. Of the liquid capacity measures the full number is finished, until to their adjustment, which requires their being weighed filled with distilled water, at the temperature of the maximum density of water, which is a most tedious and minute, therefore not very quick operation.

For the use in it a special balance has been constructed. Their actual adjustment will begin immediately after that of the yards, when the arrangements which it requires will be completed. Handles of a peculiar construction, to take off and put on, are constructed for their proper manipulation in use, without changing in the weighing.

8. As it is necessary to close the tops of the vases exactly at the proper height, to contain a determined weight of distilled water, at a given temperature, in a given cubic space of a brass vessel, it is necessary that this vessel be *exactly* covered, no air bubbles admitted in it, and no overflowing; to effect that, glass plates are required, exactly plane, of proper thickness, ground, unpolished on the side which touches the liquid, and of the size of each vessel's top; only large plate glass factories can procure these good; to construct them expressly would have necessitated a great establishment, different in its kind from all that is now established, therefore these plates have been ordered at the manufactory of plate glass of St. Gaubin, where they can be made with ease; which has established arrangements for such works, and can execute them at short notice, and with proper accuracy; they will, besides, cost a great deal less than in any other way.

9. The half bushels require a manner of casting different from that of the other parts of the work, which takes also more time and special cares; it has been in full operation, as much as possible; but this casting cannot be made in our establishment at all seasons of the year with equal success, and will, therefore, suffer temporary interruptions; during which other castings are executed. Some of these half bushels have also been turned; but it is evident that in the proper order of the work, there could not yet be any attempt towards their adjustment. The glass plates, that shall serve to cover them, have been ordered, together with those for the capacity measures for liquids for all of them: the proper size has been given to the factory for guide.

10. Thus it appears that the different tasks of the establishment for standard weights and measures have advanced properly, each in that proportion which the kind and the quality of the work they require, indicate naturally as the time required for their execution. The weights being already fully executed and delivered, except the ounce weights for the States, have made known in the country what is to be expected from the establishment, and have, I believe, given general satisfaction, which I doubt not every part of the works will give, whenever it appears before the public.

F. R. Hassler.

*Station of Willow Grove, Pennsylvania, November* 16, 1839.

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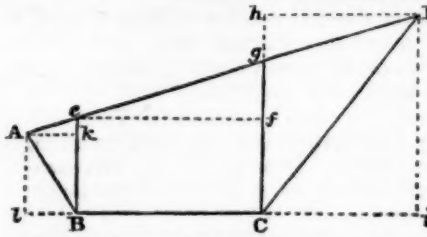
*Reply to a query relating to the Area of an Excavation or Embankment. By a Correspondent.*

To the Committee on Publications.

Gentlemen,—In the January number of the Journal of the Franklin Institute, a correspondent requests a demonstration of a formula for calcula-

ting the area of an excavation or embankment for a canal or rail road, which he gives from the London Railway Magazine.




Adopting the notation there used, and referring to the annexed figure, the given quantities are, $Be = d$, $Cg = D$, $BC = E$, and the slope of AB or CD, that is, $\frac{Al}{lB} = \frac{Di}{iC} = \frac{1}{r}$. The value of the area ABCD, is given by your correspondent's formula.

Having drawn the dotted lines shown in the figure, let $Al = Bk = x$, $lB = Ak = y$; $Di = Ch = w$, and $iC = Dh = z$.

The area ABCD is composed of the two triangles ABe, and DCg, and of the trapezoid eBCg. The area of ABe is equal to half Ak multiplied by Be; that of DCg to half Dh multiplied by Cg; and of eBCg, to the half sum of Be, and Cg multiplied by BC; or, calling the whole area A, and expressing these values algebraically,

$$A = \frac{y\,d}{2} + \frac{E\,(D + d)}{2} + \frac{z\,D}{2}$$

But, the similar triangles Ake and efg, and gDh and efg, give the proportions;

$$ek : kA :: gf : fe, \text{ and } gh : hD :: gf : fe$$

Or, since $ek = eB - kB = d - x$, and $gh = hC - gC = w - D$;

$$d - x : y :: D - d : E, \text{ and } w - D : z :: D - d : E$$

Whence:—

$$E\,(d - x) = y\,(D - d), \text{ and } E\,(w - D) = z\,(D - d);$$

And,

$$x = \frac{Ed - y\,(D - d)}{E} \qquad w = \frac{ED + z\,(D - d)}{E}$$

But from the preceding notation,

$$\frac{y}{y} = \frac{1}{r}, \text{ and } \frac{w}{z} = \frac{1}{r} : \text{hence, } x = \frac{y}{r} \text{ and } w = \frac{z}{r};$$

Equating the two values of $x$ and of $w$;

$$\frac{y}{r} = \frac{Ed - y\,(D - d)}{E}, \text{ and } \frac{z}{r} = \frac{ED + z\,(D - d)}{E}.$$

From these equations;

$$y = \frac{rEd}{E + r\,(D - d)}, \text{ and } z = \frac{rED}{E - r\,(D - d)}$$

Substituting these values for $y$ and $z$ in the expression for the area, we have the formula of your correspondent,

$$A = \frac{rE\,d^2}{2E + 2r\,(D - d)} + \frac{E\,(D + d)}{2} + \frac{r\,ED^2}{2E - 2r\,(D - d)}$$

O. C.

*Statement of the Performance of the Locomotive Engine "Gowan and Marx," built by Messrs.* EASTWICK & HARRISON, *Philadelphia, on the Philadelphia and Reading Rail-Road, with a train of one hundred and one loaded Cars. February 20th*, 1840.

Gross weight of train, including cars and freight, but not including Engine or Tender, 423 tons of 2240 lbs.

Net weight of freight, 268¼ tons of 2240 lbs.

The freight consisted of—2002 barrels of flour, 82 do. whiskey, 459 kegs of nails, 19 tons of bar iron, 22 hhds. of meal, 5 do. whiskey, 4 do. oil, and sundry other articles, making a total of 268¼ tons.

Distance from Reading to the foot of the Inclined Plane on the Columbia Rail-Road, 54¼ miles. Running time of the engine with train, five hours thirty-three minutes; rate 9.82 miles per hour. Coal consumed, red ash anthracite, from Schuylkill county, 5600 lbs. Water evaporated, 2774 gallons.

*Grades of Road.*

The total fall from Reading to the point where the train was stopped near the Columbia Rail-road, is 214.5 feet, being an average fall of 3.94 feet per mile. There is *no ascending grade* from Reading to the Columbia Rail-Road, with the exception of about 2100 feet at its lower termination, graded at 26.4 feet per mile, upon which grade the train was stopped: the other grades vary from 19 to 15 feet per mile: there are only three miles graded at 18 feet and one at 19 feet per mile.

The total length of *dead level* line from Reading to the Columbia Rail-Road is 27 miles and 4200 feet: of this, the longest level is 9 miles and 500 feet long, between Norristown and the inclined plane: the others vary from 1550 feet to 4 miles and 1600 feet in length.

*State of the Track.*

Owing to the frost coming out of the ground at this season, the track was in worse order than at any other time of the year; this, however, did not materially affect the performance of the engine, as the embankments were all in nearly as good order as at other times: and at comparatively few points in the deep cut, was the track sufficiently out of line or level to offer increased resistance to the train.

The superstructure of the road consists of a T rail, 45 lbs. to the yard laid upon sills 7 feet long and 7 by 8 inches square, 3 feet 1½ inches apart from centre to centre, and laid on broken stone.

*State of the Rails.*

For the first twenty miles the rails were in very bad order, the morning was cloudy, and a fog of the previous night had left sufficient moisture on the surface of the rails to diminish considerably the adhesion of the engine: for the remainder of the distance the weather was clear, and the rails in good order.

*Working of the Engine.*

On three different occasions the engine started the whole train on a dead level, and when on a dry rail, without the wheels slipping.

The steam ranged from 80 lbs. to 130 lbs. per square inch, to which latter pressure the safety valve was screwed down.

The draught of the engine was created by the escape steam passing into, and from, a tubed exhaust box—no other draught was used while running: at the water stations, "Reilly's patent fan" was used when fresh coal was thrown on the fire, but at no other time.

The speed of the train was noted when passing through some curves of 819 feet radius on the 9 mile level, and found to be 9.8 miles per hour: on a straight line on the same level, the engine attained a speed of 10.5 miles per hour.

So little was the engine affected by her performance on the 20th, that on the 23rd she drew, on her return trip, 88 burden cars, 9 of which were loaded, and a locomotive engine, making a gross weight of 163 tons of 2240 lbs., not including engine or tender, up a grade of 18.4 feet per mile. The train had a strong head wind against it during the whole trip, which, owing to its length, 1206 feet, was sensibly felt at some exposed points of the road, and must have proportionably affected the power of the engine.

*Weight and Dimensions of the Engine, "Gowan and Marx."*

Weight when empty 21,640 lbs. In running order, with fuel and water, 24,660 lbs., on four driving wheels in running order, or with water, fuel and two men, 18,260 lbs. Cylinders $12\frac{2}{3}$ by 16 inch stroke; 8 wheels, 4 of which are driving wheels, coupled, 3 feet 4 inches diameter; truck wheels 2 feet 6 inches diameter.

The weight of the burden cars averaged from 1.5 to 1.65 tons, of 2240 lbs. each: they were all 4 wheeled—wheels 3 feet diameter, and 4 feet 6 inches apart from centre to centre.

The above performance, of an 11 ton engine, is believed to exceed any on record in this or any other country.

G. N. Nicolls,
*Superintendent Transportation, Philad. and Reading R. R.*
*Reading, Feb.* 24, 1840.

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## Bibliographical Notice.

*An Introduction to Astronomy; designed as a Text Book for the Students of Yale College. By* Denison Olmsted, *A. M., Professor of Natural Philosophy and Astronomy. New York—Collins, Reese, & Co.*, 1839. *pp.* 276, 8*vo.*

The above is the title of a new publication, on the Elements of Astronomy, by a gentleman whose name is already well known to the scientific public, as the author of a treatise on Natural Philosophy, and as a writer on the subject of Meteorology, in several articles which have appeared in Silliman's Journal. We had previously two American works on the elements of Astronomy; one by Prof. Gummere, of the Haverford Institution, near Philadelphia; and the other by Prof. Norton, now of Newark College, New Jersey; each having its peculiar merits, and each, as we think, having its faults, regarded as a College Text Book. We are obliged to express the same opinion of the work now before us; and whether it be considered as a defect or as an excellence, we think it the most popular and the least abstruse of the three. For ourselves, we would have perferred a greater amount of algebraical investigation; but perhaps that desideratum will be supplied in

the second part, which is yet to appear, and for which the calculations of eclipses, and other problems, with the requisite tables, are reserved.

After preliminary observations on the History of Astronomy, and the Copernican system, Prof. Olmsted naturally commences with the Figure of the earth, and the Doctrine of the Sphere; then treats of Parallax and Refraction, the measurement of Time, and the use of Instruments. He next proceeds to the Solar System, the Sun, and its apparent annual motion, with its causes and effects; after which follows the theory of Universal Gravitation; next the study of the Moon, its motions and phenomena, then the study of the Planets, beginning with the inferior; next that of the Comets; and lastly the study of the Fixed Stars; in regard to which last, this work is more full and satisfactory than its contemporaries. We think that the measurement of Time would have been taken more properly in connection with the Sun's apparent motion in a subsequent chapter; with which exception the general arrangement seems to be very judicious. Still, in our judgment, the value of the work would be enhanced, by a larger proportion of analytical demonstration, and exact, instead of approximate data; which though not necessary to the common reader, are yet important to the inquisitive or practical student. With these remarks we conclude by saying that every teacher of Astronomy will derive advantage from an examination of this, as well as of the other works herein named; but each one must judge for himself which work is best adapted to the wants and capacities of his pupils.

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## Franklin Institute.

### *Annual Meeting.*

The annual meeting of the Institute was held at their Hall, January 16th, 1840.

Thomas Fletcher, Vice President, in the Chair;

John G. Clark, Recording Secretary, P. T.

The minutes of the last quarterly meeting were read and approved.

Donations were received from the Royal Geographical Society, of London; the Institution of Civil Engineers, of London; the Zoological Society of London; Prof. M. Faraday, William Vaughan, Esq., and Petty Vaughan, Esq., of London; the Royal Irish Academy, of Dublin; Prof. Jno. Millington, of Virginia; L. D. Chapin, Esq., Wm. C. Redfield, Esq., and Jno. D. Griscom, M. D. of New York; Mr. Jonathan Dennis, Jr., of Rhode Island; Major James D. Graham, Washington City; J. Edgar Thompson, Esq., Professor Denison Olmsted, of Connecticut; John C. Trautwine, Esq., of Tennessee; J. R. Livingston, Esq., and Thomas Ridgway, Jr. Esq., of Pennsylvania; William Strickland, Esq., L. Vanuxem, Esq., Henry Seybert, Esq., James J. Barclay, Esq., Chas. Ellet, Jr. Esq., R. C. Taylor, Esq.; Professors Henry D. Rogers, and Alex. Dallas Bache, the Medical Society of Philadelphia; the Trustees of the Girard College for Orphans; the Mine Hill and Schuylkill Haven Rail Road Company; and Messrs. Thomas Wardle, John Wilson, Jacob Snider, Jr., John D'Homerge, George W. Edwards, Esq., B. M. Hinchman, Esq., Samuel Cupp, Esq., James Ronaldson, Esq., and Jacob Lex and Son, of Philadelphia.

The Actuary laid on the tables the periodicals received in exchange for the Journal of the Institute.

A communication was read from Mr. John R. Lambdin, accompanied

by a likeness of James Ronaldson, Esq., the President of the Institute, painted and presented by Mr. Lambdin. The frame presented by Mr. John Struthers.

The annual report of the Board of Managers was read and accepted, and referred for publication.

The Treasurer presented his report of the funds for the last quarter, and also a statement for the year ending December 31st, 1839, which were read and accepted.

Mr. John Horten, from the Committee of Tellers of the annual election for Officers and Managers of the Institute for the ensuing year, (appointed at the preparatory meeting this day), presented their report of the result of the election; when the Vice President declared the following gentlemen duly elected.

JAMES RONALDSON, President.

ISAIAH LUKENS, THOMAS FLETCHER, } Vice Presidents.

ISAAC B. GARRIGUES, Rec. Sec.

ALEX. DALLAS BACHE, Corr. Sec.

FREDERICK FRALEY, Treasurer.

*Managers.*

| | |
|---|---|
| Samuel V. Merrick, | Andrew M. Eastwick, |
| Abraham Miller, | Isaac P. Morris, |
| William H. Keating, | Charles B. Trego, |
| John Struthers, | Henry Troth, |
| Matthias W. Baldwin, | John S. Warner, |
| Isaac Hays, | William Hart Carr, |
| J. Henry Bulkley, | Robert M. Patterson, |
| Alexander Ferguson, | Henry D. Rogers, |
| John Agnew, | John Gilder, |
| John Wiegand, | Ambrose W. Thompson, |
| Samuel Hufty, | George Taber, |
| John C. Cresson, | Thomas U. Walter. |

Extract from the minutes.

THOMAS FLETCHER, *Vice President.*

JOHN G. CLARK, *Rec. Sec. P. T.*

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*Sixteenth Annual Report of the Board of Managers of the Franklin Institute, of the State of Pennsylvania, for the promotion of the Mechanic Arts.*

In conformity with the Constitution, the Board of Managers respectfully present to the members of the Franklin Institute their report for the past year, containing a brief summary of the operations in the several departments of the Institution. The leading object of the Association, that of giving opportunities of increase in knowledge to its members, and those connected with them, has as heretofore been steadily kept in view. The lectures on science and its application to the arts continue under the charge of our able Professors to instruct and interest the large class in attendance upon them, and embrace as usual the subjects of chemistry under the charge of J. K. Mitchell, M. D., Natural Philosophy and Mechanics under that of Prof. Jno. C. Cresson, and of Technology under that of Prof. James C.

Booth. It is due to these gentlemen to express the continued satisfaction felt by the Board with their exertions; an expression in which they are sure they are joined by the classes in attendance upon the lectures. In addition to members tickets for the lectures, there have been issued this year, 45 lady's tickets; 216 minor's tickets, and three stranger's tickets. The course of the Drawing School has been interrupted by a cause calling for the sympathy of the members, the long continued illness of the teacher, Mr. William Mason; the Board are happy to state that Mr. Mason has been able to provide a substitute in his son, already an experienced teacher, and the school was opened on the 13th of the present month under his charge.

The situation of master in the Architectural department of the Drawing School, rendered vacant by the resignation of Mr. John McClure, has not been filled, owing to the fact that the Carpenter's Society had opened a school under their direction, with the success of which, the Board were unwilling in any way to interfere, and which they have supposed supplied all the requisites of their own school.

The committee on the library have been active in endeavoring to add by purchase to the already useful collection of scientific works belonging to the Institute. During the past year 108 vols. have been added by purchase, 32 by exchange, and 24 by donations, and the library now contains 2364 vols., exclusive of a large collection of Pamphlets. The number of periodicals received for the use of the reading room has been increased by the addition of several foreign Journals, and the list of newspapers has been kept at its former extent. The cabinets of minerals and models have been increased by donations; the former being now well arranged affords useful means for the study of Mineralogy, or for reference; the latter occupies an increasing share of attention, especially from strangers visiting the city, and introduced by members; it may, when the means of the Institution shall allow, be made a source of great attraction, and of much solid popular instruction.

No opportunity has yet occurred to enable the Board to press further the establishment of a School of Arts, but the importance of the object is by no means lost sight of. The Monthly Meetings of the Institute, which afford suitable occasions for bringing forward new inventions and discoveries, have been kept up with spirit thus far during the season, and are well attended.

In addition to these modes of conveying instruction to the members, the Journal of the Franklin Institute was established to diffuse knowledge on Mechanics and other branches of science in even a wider circle. In its department of original matter, this journal affords a vehicle through which mechanics, engineers, and men of science may bring their views before the public, and here, also, carefully prepared notices and descriptions of patents for American inventions are to be found. These notices and descriptions are the fruits of the labor of Dr. Thos. P. Jones, whose experience and ability in this particular line are universally admitted. Instead of presenting a crude mass of matter, good and bad, by publishing indiscriminately the specifications of all patents, the Editor is at the pains to give abstracts containing the substance of the whole, and only in cases where the subject warrants, giving the entire specification to the public. The selections from foreign Journals form the chief labor of the second Editor, Prof. John Griscom. The efforts made in securing the services of gentlemen so eminent in their respective lines as the Editors whose names have just been given, and, in addition, the payments usually made for original articles for the pages of the Journal, are proofs that the Board continues, through its Committee of

Publications, to appreciate highly the good to be accomplished by the Journal in the promotion of the mechanic arts, and in the diffusion of useful knowledge.

Researches in science have at different times been fostered by the Franklin Institute: the labors of the Committee on Water-Wheels, and on the Explosion of Steam-Boilers have been brought to a close, and have each contributed to win for the Institute the reward of commendation for useful exertion rightly applied. The Committees on Science and the Arts, and that on Meteorology, may be ranked with the foregoing, as giving encouragement to researches, though not personally engaged as Committees in executing them. The Committee on Science and the Arts have examined by Sub-Committees thirty-nine different inventions or improvements during the past year. When the Committee acted merely as the counsellors of the inventor, the reports are not considered matter for publication; in other cases, when the objects seemed worthy of it, the reports have been ordered for publication in the Journal of the Franklin Institute.

The Scott's legacy premium and medal, the award of which is entrusted by the City Councils to the Franklin Institute, has been conferred by this Committee on three of the gentlemen whose inventions were submitted to them, namely, on Thomas Wood, M. D., for a fountain pen, and mechanical method of determining areas; on Thomas Ridgway, Jr., for a transit theodolite for mining engineers; and on L. C. Denison, for a Corn-sheller. The medal to accompany this premium has been prepared, and is a beautiful specimen of the Art; the obverse has a head of Franklin in high relief, and the reverse the words "The Scott Premium. To the most deserving." The die was executed in the transfer lathe by Franklin Peale, Esq., by the aid of an iron casting admirably executed by Isaac Babbitt, of Taunton, Massachusetts. At the first meeting of the Committee in 1839, the Chairman, Dr. R. M. Patterson, having declined a re-election, Prof. A. D. Bache was chosen Chairman.

The Committee on Meteorology have continued the distribution of the instruments ordered by the State of Pennsylvania, to observers in the different counties, and report a condensed statement of the observations through the pages of the Journal.

The importance of exhibitions of domestic manufactures, and of the products of the various branches of the Mechanic Arts from time to time to improvement in their several branches is now generally conceded. The last exhibition of this kind held by the Franklin Institute was successful beyond former experience in the number and value of the products exhibited, and in the number of persons to whom they were displayed. The labors of the last Committee on premiums and exhibitions, will, it is hoped, be emulated by their successors, that the exhibition in the Autumn of 1840, may be rendered even more extended than that of their predecessors.

In conclusion, the Board of Managers must congratulate the Institute, that notwithstanding the pressure of the times which have weighed with peculiar severity upon those, upon whom the Institution depends for its support, the number of members has not been diminished, and the payments have generally been punctually met. The same is the case in relation to subscribers to the Journal. It may well be a satisfaction, that while in other years there has been an increase in the means of usefulness of the Institute; there has been during the past year no loss in reference to them. The proceedings of the late special meeting of the Institute to authorize the sale of property, are too recent to demand special notice in this report.

During the past year 125 new members have been elected, 100 members have resigned, and 21 have died. The following named gentlemen have become life members—

Hector Orr, Edward Miller, Ellwood Morris, Richard C. See, Jos. M. Truman, Erastus Fairbanks, A. L. Elwyn, M. D., George W. Smith, William Ashbridge, Jacob Ott, I. P. Morris, Jno. Struthers, and W. H. Carr.

Respectfully submitted by

JOHN AGNEW, *Chairman.*

WILLIAM HAMILTON, *Actuary.*

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*Minutes of the Board of Managers.*

At a meeting of the Board of Managers, held at the Institute, January 29th, 1840,

Mr. JOHN C. CRESSON was elected Chairman of the Board; and

Messrs. HENRY TROTH, and J. HENRY BULKLEY, Curators, for the ensuing year.

At a meeting of the Board, held February 19th, the Chairman nominated the Standing Committees, agreeably to the by-laws. On motion, Alfred Langdon Elwyn, M. D., was added to the Committee on the Library; John McClure, and Thomas S. Stewart, to the Committee on the Cabinet of Models; James C. Booth, and John F. Frazer, to the Committee on the Cabinet of Minerals; John C. Cresson, to the Committees on Publications, and on Premiums and Exhibitions; Roswell Parke, Jno. C. Cresson, Robert Hare, M. D., John K. Mitchell, M. D., and Jos. Saxton, to the Committee on Monthly Meetings; William Kirk, Charles Thomas, and Josiah Evans, to the Committee on the Exchange; Robley Dunglison, M. D., James P. Espy, C. N. Bancker, John K. Kane, Sears C. Walker, John C. Cresson, and Gouveneur Emerson, M. D., to the Committee on Meteorology; when the Committees were appointed as follows:—

*On the Library.*

| | |
|---|---|
| Henry Troth—Chairman | Ambrose W. Thompson, |
| Isaac Hays, M. D. | Thomas U. Walter, |
| Isaac P. Morris, | A. Langdon Elwyn, M. D. |
| J. Henry Bulkley, | |

*On the Cabinet of Models.*

| | |
|---|---|
| Isaac P. Morris—Chairman | George Taber, |
| John Struthers, | John Agnew, |
| Andrew M. Eastwick, | Thomas U. Walter, |
| Isaiah Lukens, | John McClure, |
| William Hart Carr, | Thomas S. Stewart |
| John Gilder, | |

*On the Cabinet of Minerals.*

| | |
|---|---|
| Charles B. Trego—Chairman | Henry D. Rogers, |
| Isaiah Lukens, | Thomas Fletcher, |
| Samuel Hufty, | James C. Booth, |
| Abraham Miller, | John F. Frazer. |

*On Publications.*

| | |
|---|---|
| John C. Cresson—Chairman | Samuel V. Merrick, |
| Isaac Hays, M. D. | Matthias W. Baldwin, |
| Alex. Dallas Bache, | Isaac P. Morris. |

*On Premiums and Exhibitions.*

John C Cresson—Chairman
Alex. Dallas Bache,
William H. Keating,
Alexander Ferguson,
Thomas Fletcher,
Isaac B. Garrigues,
John S. Warner,
John Agnew,
Thomes U. Walter,
John Struthers.

*On Instruction.*

Alex. Dallas Bache, Chairman.
Frederick Fraley,
John Wiegand,
Isaac P. Morris,
Abraham Miller,
Charles B. Trego,
Henry Troth,
Henry D. Rogers.

*On Monthly Meetings.*

Alex. Dallas Bache, Chairman.
Robert Hare, M. D.,
John K. Mitchell, M. D.,
Joseph Saxton,
Andrew M. Eastwick,
John Wiegand,
John S. Warner,
William Hart Carr,
Roswell Parke,
J. Henry Bulkley,
John C. Cresson,
George Taber.

*On the Exchange.*

John S Warner—Chairman
John Struthers,
Andrew M. Eastwick,
Isaac B. Garrigues,
John Gilder,
William Kirk,
Charles Thomas,
Josiah Evans.

*On Meteorology.*

R. Dunglison, M. D.—Chairman.
James P. Espy,
Charles N. Bancker,
John K. Kane,
Henry D. Rogers,
Sears C. Walker,
John C. Cresson,
Gouveneur Emerson, M. D.

*On Finance.*

Alex. Ferguson—Chairman
William H. Keating,
Samuel V. Merrick,
Frederick Fraley,
Henry Troth.

*Managers of the Sinking Fund.*

S. V. Merrick—Chairman
Frederick Fraley,
Alexander Ferguson.

*Auditors.*

Isaac B. Garrigues—Chairman.
William Hart Carr,
Ambrose W. Thompson.

(Extract from the minutes.)

JOHN C. CRESSON, *Chairman.*

WILLIAM HAMILTON, *Actuary.*

# Mechanics' Register.

## LIST OF AMERICAN PATENTS WHICH ISSUED IN FEBRUARY, 1839, *With Remarks and Exemplifications by the Editor.*

1. For an improved *Loom for Weaving Fringe and Trimmings;* Eliza A. B. Judkins, Portland, Maine, February 2.

This loom does not differ in its general construction from those already in use, but to obviate some inconveniences experienced in the ordinary loom, a new arrangement of certain parts is described and represented, and to these the claim is confined; a transcript of the claim would be of no use without the drawing.

2. For improved *Cast Iron Wheels for Cars, &c.;* William W. Pennell, city of Lancaster, Pennsylvania, February 8.

This wheel is without spokes, one side of it consisting of an entire plate, which is supported by radiating brackets connected with it and with the hub. Towards the rim there is a circular cavity extending all around the wheel, which is formed by a core supported through openings left in the face of the wheel for that purpose.

The claim is to the constructing this wheel and combining the several parts together; "that is to say, in combination, the forming of the part towards the rim hollow, in the manner described, whilst the part towards the hub consists of a single plate, the two parts being connected and supported by brackets, as set forth."

3. For a *Machine for making Oakum;* James Tibbals, Haddam, Middlesex county, Connecticut, February 8.

A cistern, or trough, is to be made which may be of wood, and this is to contain water to be heated by means of a furnace below the bottom of the cistern. The junk, cut into proper lengths, and opened by hand, is to be hung upon bars forming part of a vibrating carriage, traversing upon railways, so that the junk shall hang within the water, where it is to be subjected to the action of said water, assisted by a rapid vibratory motion of the carriage: when one end of the junk has been acted upon, the ends are to be reversed. The claim is to "the combination of the said horizontal carriage and its appendages with the other parts of the said machine, as above set forth; carrying junk in strands equally back and forth in hot water; and the application of the principle of vibratory motion, in the manner set forth, to the manufacture of oakum."

4. For an improvement in *Bedsteads, Chairs, Sofas, &c.*; Edmund Chenington, Boston, Massachusetts, February 9.

The apparatus here patented is for raising and lowering the head part of beadsteads, sofas, &c., in a manner so analogous to what has been before, and frequently, done, that it is not worth while to attempt a description, or to give the claim; the latter, indeed, would not afford any idea of the peculiar arrangement of levers, &c., as made by the patentee, and to this, of course, he is limited.

5. For improvements in *Tanning;* William Brown, Thompson, Sullivan county, New York, February 9.

The improvements are said to consist in the changing the position of hides, sides, and skins, in the liquors, in all the different processes of tanning; viz, Liming, Bating, and Tanning, as a substitute for the ordinary mode of drawing, hauling, and laying away.

The hides, or skins, are to be suspended so as to hang down vertically, and parallel to each other, by taking two pieces of timber, and keeping them apart by a stretcher of the proper length for the vat, *a*,|———|*a*, the short pieces *a*, *a* may represent the ends to which the skins are attached, and the long line the stretcher. The workman, walking upon a plank laid along the vat, is to remove this apparatus back and forth, by means of two handles extending up from the end pieces. The claim is to this arrangement.

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6. For *Temples for Looms;* Jonathan Dennis, Jr., assignee of Kendall Gibbs, South Berwick, York county, Maine, February 13.

The patentee says that the nature of his invention "consists in constructing the temples with a joint, so that if the shuttle stops between the temple and the reed, the temple will be pressed back by the shuttle as the lathe strikes against the cloth, without injury to the shuttle, temple, or reed; this joint also allows the temple to vibrate towards the reeds, as it opens, and after it shuts; as the lathe leaves it, it vibrates from the reed with a reacting motion which makes the selvage, or threads, at and near the edge, tight, to any degree that the operator may require, thereby facilitating the entrance and exit of the shuttle."

After describing the particular arrangement of the temple, a claim is made thereto, referring to the matters so described. The temple is of the kind which holds the selvage between jaws, which are opened in the ordinary manner of such jaws, and the whole bears a very near resemblance to some temples which have been previously in use; the claim, if inserted, would not point out the particular difference.

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7. For a *Paint Mill;* Joseph W. Webb, Mount Morris, Livingston county, New York, February 15.

A horizontal plate, which may be sixteen inches in diameter is to receive the paint to be ground. Towards the opposite sides of this there are to be two mullars, which may be cast six inches in diameter, and these are to be made to revolve on their own axes, by means of proper gearing, as well as around the plate. The mullars are to be surmounted by cups, or hoppers, into which the paint is to be put, which descends through an opening in the middle of the mullars. The bed plate is to be surmounted by a ledge to keep the paint from running off. The claim is to "the employment of two or more mullars constructed as herein described, which revolve around the centre of the bed plate whilst they rotate upon their own centres, as herein described."

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8. For a *Liquid for burning in Lamps;* Augustus V. X. Webb, city of New York, February 19.

The liquid here patented the patentee denominates *Camphine*, or *Camphine oil*, and the patentee says that the nature of his discovery consists in "distilling with potash, or other alkali, and water, turpentine, or the spirit or oil of the turpentine, or other essential oils, whether separate or combined;

the results of which distillation is a liquid I denominate camphine." A still is described which is so constructed as to allow only the lighter parts of the fluid to pass over to the condenser, and the following claim is then made.

"What I claim as my discovery and desire to secure by letters patent, is the manufacturing of the liquid here denominated camphine, or camphine oil, which is produced by distillation with water and potash, or other alkali, turpentine, or other spirits, or the oil of turpentine, or other essential oils, whether separate or combined, and by whatever apparatus or mode the distillation may be effected."

We do not know of any substantial change that would be produced in the composition of the essential oil by the proposed process, and most assuredly, the process itself of distilling the essential oils from potash and water, has been performed times without number, although not for the purpose here proposed.

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9. For a *Lamp* for burning the liquid called Camphine; Augustus V. X. Webb, city of New York, February 19.

The lamp is of the kind formed by the frustums of two cones united at their edges, so as to leave the centre of the body free for the descent of the light from the burner; such lamps are in common use. The claims are to "the construction of the burner with a circular and continuous aperture between the upper edges of the frustums, to admit either a continuous cicular wick in the form of a hollow frustum of a cone, or a circular perforated ring or plate to be used for burning camphine or any other article." The peculiar form of the glass chimney is also claimed; which form differs but little from those in common use, but possibly it may be thereby better adapted to the burning of the spirit employed, a question to be decided by experience only. There is a claim also to the regulating of the light by the raising or lowering of the chimney.

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10. For an improvement in *Fire Arms;* Libbeus Bailey, of Portland, Maine, John B. Ripley, of Claremont, and William B. Smith, of Cornish, New Hampshire, February 20.

The gun which is the subject of this patent is to receive its charges at an opening in the end of the breech. The particular arrangement of its parts cannot be given, these being too complex for verbal description, but the following quotation from the specification will afford some general idea of the general plan.

"This fire arm can be discharged about fifteen times to one loading; the operation is as follows: Fifteen sliding chambers are loaded with powder and ball, and a percussion cap pressed firmly upon each of the cones; these chambers are then passed into the cylindrical conducting tube through the opening at the breech of the gun, and then closed by shutting the cover; the gun is then brought to the shoulder and discharged; the gun is then brought down to a level with the hip, the cock drawn back with the thumb of the left hand, which leaves the drop free; the trigger is then pulled, the bolt drawn back, and the drop falls, and the discharged chamber falls into the left hand, the gun is then turned over with the barrel down, a slight motion will cause one of the sliding chambers to pass from the cylindrical tube into the receiving chamber, the apron, or drop, is then pushed down into its place, and the gun brought again to the shoulder and discharged, repeating the operation until the fifteen charges are expended."

If this gun has not yet followed the course of the numerous "improved fire arms" which have been made the subject of previous patents, it is no doubt on the road. There are few subjects upon which so much misapplied ingenuity has been expended within four or five years, as upon that of fire arms. They have been destined to be the subjects of a *report*, and have then been laid upon the table; and, we believe that the single barrelled gun, with its single charge, will not be generally superceded, either for the use of the army, or of the sportsman.

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11. For *Revolving Flashing Lights for Light Houses;* Benjamin F. Williams, Boston, Massachusetts, February 20.

The claim made under this patent is to the "rendering the revolving lights of light houses distinguishable from other revolving lights by means of vertical revolving shades, turned by wheels moving on a circular railway to the axis of which the shades are fixed, directly in front of the lights, which, when in motion, will cause the lights to appear and disappear in quick succession of sudden flashes."

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12. For a machine for *Pressing Hay, Cotton, &c.;* Joseph C. Baldwin, Staunton, Augusta county, Virginia, February 22.

This press operates by means of double progressive levers, of the kind called the toggle joint. The levers are connected to each other by a curved rack which is moved back and forth by a pinion gearing into it, which straightens the pairs of levers alternately. One end of each pair works on a joint in the frame work, whilst the other ends operate on notches in the shaft of a follower, acting, respectively, on its opposite sides, and alternately forcing it on, whilst they also alternately act as palls in holding it in place. The press is placed horizontally.

The specification of this patent has been amended, and the patent reissued; when we arrive at the reissue we expect to present it with an engraving.

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13. For *Protecting Plastered Walls and Ceilings from fire;* Peter Naylor, city of New York, February 22.

(See Specification.)

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14. For a *Corn Sheller;* Alonzo R. Dinsmore, Chester, Rockingham county, New Hampshire, February 24.

This is said to be an improvement on Harris' corn sheller, a notice of which will be found at p. 262, of vol. xvii. The rubbing boards, in this improved machine are to be curved, one of them being made convex, and the other concave, by which change of form it is said that the machine will be rendered more efficient. This may be so, but we see no reason to alter the opinion originally formed and expressed respecting it, which is that it will be found to be one of the least useful of the shelling machines.

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15. For a *Crane Excavator;* William S. Otis, Civil Engineer, city of Philadelphia, February 24.

This apparatus is to be applied to the purpose of excavating in the constructing of railroads, and canals, and it has been used to a considerable extent by the inventor, and found to facilitate the operation to a very great extent. From the nature of the instrument its particular arrangement could only be made known by means of the apparatus itself, or of the draw-

ings. The apparatus excavates "by means of certain appendages to a scraper of the ordinary construction, which scraper is to be worked by a crane, and is to take the earth immediately from the banks from which the excavations are to be made.

"Although the improvement consists mainly in the manner in which I employ the scraper for excavating by means of the crane, I do not make any claim to the mere using of the scraper by means of the crane, this having been before done; but what I do claim in the apparatus described, is the application of power to force the scraper forward against a bank, in the act of excavating, and to withdraw it at pleasure by the aid of a barrel, chains, and other apparatus, constructed and operating substantially in the manner described, by which its sudden recoil will be prevented as it encounters any unusual resistance."

There are some other claims referring to particular parts, as represented, which it is unnecessary to insert.

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16. For an improvement in the manner of *Preparing Caoutchouc, Gum Elastic, or Indian-rubber;* Charles Goodyear, Boston, Massachusetts, Assignee of Nathaniel Hayward, Woburn, Middlesex county, Massachusetts, February 24.

(See Specification.)

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17. For a *Steam Apparatus*; Abraham Patterson, Rush, Susquehanna county, Pennsylvania, February 26.

This apparatus is said to be a substitution for the ordinary steam cylinder, a steam gauge, or a safety valve; yet we venture to pedict that it will not be used for either purpose. In all its forms it consists of a cylindrical vessel, closed at its upper end, and open below, its lower end passing in between two concentric cylinders exactly in the manner of the gasometers used by chemists. Mercury is to be used to surround the first named cylinder, in the annular space within which it is to rise and fall, steam is to be admitted to cause it to rise, and to be condensed to cause it to fall. The claim is to "the employment of an apparatus constructed as herein described as a substitute for a steam cylinder and piston of a steam engine, and the safety valve of steam boilers. And I also claim the employment of mercury in the said apparatus for the double purpose of packing and steam gauge."

When this engine comes into beneficial use we will say more about it.

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18. For improved *Tailor's Shears;* Rochus Heinisch, city of Newark, New Jersey, February 27.

This improvement consists in widening out and so forming certain parts of the bows of the shears, as to constitute a bearing for the hand in grasping and using them, rendering it more easy to exert the necessary force in cutting. This is, no doubt, a real improvement; the claims are to the so constructing the shears, as described.

*Specification of a Patent for a mode of protecting Plastered Walls and Ceilings against the effect of fire; granted to* Peter Naylor, *city of New York, February 22nd,* 1839.

To all whom it may concern: Be it known that I, Peter Naylor, of the city of New York, in the State of New York, have invented a new and improved mode of protecting the walls and ceilings of such apartments as are usually finished with lath and plaster, against the effects of fire, by substituting perforated plates of metal for the laths of wood usually employed; and I do hereby declare that the following is a full and exact description thereof.

I take thin sheets of metal; preferring, so far as my experience has gone, tin plate, as prepared for the purpose of manufacturing tin ware, as I have reason to believe that the tinning protects the iron completely from the action of the lime used, and from oxidation generally. I do not intend, however, to confine myself in this particular, but to use any kind of sheet metal which I may find adapted to my purpose. When tin plate is used, the distance of the joist, or of the timbers generally to which it is attached, must be within the limits of the length of such plates,) but when sheet iron or other metal is employed, the distance may be greater.

I take the sheet metal which is to be used, and I punch numerous holes through it in the manner of a grater, using either a round, or chisel-edged, punch, as may be preferred; the diameter of these holes may be from an eighth to a quarter of an inch. When the plates have been so punched I nail them on to the joist, scantling, or studs, with the burred edges of the perforations outwards. For greater security I take strips of hoop iron which strips I nail on to the timbers, before nailing the sheet metal, and when this is done it would be difficult to heat the metal through its two thicknesses sufficiently to set fire to the timber, even without the protecting influence of the plaster.

The sheets of metal may be seamed together at their edges before nailing them on. When the sheet metal has been properly secured to the timbers I proceed to plaster the walls in the usual manner, omitting, however, the first rough coat which is necessary when laths of wood are employed. The plaster will pass through the numerous perforations in the sheet metal, and will be as securely keyed, and retained in place, as when done in the ordinary way. It has been found also, by experiments carefully performed, that the plaster will not flake off by a long continued heat so readily as it does from wooden laths, which warp and twist, and thereby aid in loosening the plaster.

What I claim as my invention, and desire to secure by letters patent, is the use of perforated sheet metal as a substitute for laths on walls and ceilings to be plastered, using and applying the same substantially in the manner herein set forth.

Peter Naylor.

*Specification of a Patent for an improved Mould-board for a Plough; granted to* SAMUEL WITHEROW, *of Gettysburg, in the county of Adams, in the State of Pennsylvania, and* DAVID PIERCE, *of the city of Philadelphia, October*, 1839. *Patent assigned to Samuel Witherow.*

To all whom it concerns: Be it known that we, Samuel Witherow of Gettysburgh, in the county of Adams and State of Pennsylvania, and David Pierce of the city of Philadelphia, in the same State, have invented an improvement in the manner of forming the mould boards of Ploughs, denominated by us the cycloidal mould board; and we do hereby declare that the following is a full and exact description thereof.

It is a principle resting on mathematical demonstration that a cycloidal arc, is that which offers the least resistance to a descending body; and it is hence deducible that an ascending body will pass up a cycloidal curve with less resistance than up any other.

The construction of our mould boards is dependent upon this principle. In forming them we employ the cycloidal curve in two ways, namely, to the formation of the concave of the mould board in the lines of ascent of the sward or furrow slice, in the act of ploughing. The second application of the cycloidal curve, is in the convex curve along the sole of the plough, constituting the part which enters and cuts the ground horizontally.

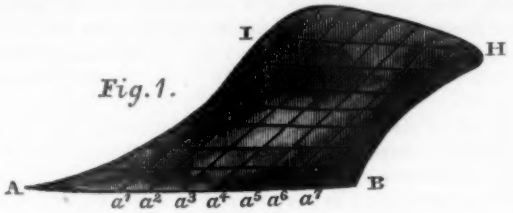
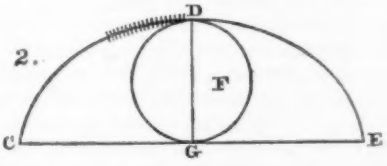



*Fig. 1.*




2.

In the accompanying drawing, fig. 1, represents a mould board, A, being its point, and B, its heel; the line A, B, is that of the sole, constituting the lower edge which cuts the furrow slice horizontally. This curve in a plough which has been essayed, and has been found to answer well, was generated by a circle of eighteen inches in diameter.

In fig. 2, the curve C, D, E, may represent the cycloid generated by the circle F, the point D, which is that of the least curvature, corresponds with the point A, of the plough, fig. 1, the cycloidal line continuing to the hind part, or heel, at B. It will no doubt be advantageous to vary the curve according to the nature of the soil, a point to be determined by experience, but whatever variation may be found useful in this respect is still to be made in conformity with the principle upon which we proceed, namely, that of making it cycloidal. The line I, H, along the upper part of the mould

board, and in a plane parallel to that of the plane of the line A, B, we also make to fit the same cycloidal gauge.

In the plough which has been put in operation for the purpose of testing the principle, the lines of the ascent of the furrow slice, which govern the concavity of the mould board were regulated by a cycloidal gauge made to a curve, generated by a circle of sixteen inches in diameter. Let C, D, G, fig. 2, represent such a gauge, and the lines $a^1$, $a^2$, $a^3$, fig. 1, be assumed as those of the ascent of the furrow slice on the mould board; in forming said board we place the gauge in the direction of the line $a^1$, with the part D, which is that of least curvature at $a^1$, and thus proceed on until we arrive at the hinder part, B, H, withdrawing, or lowering, the gauge at its lower end at each successive application, so that a smaller portion of the least curved portion towards D, and a larger portion of that towards C, shall touch the mould board; these successive depressions may be indicated by the divisions at *b*, upon the gauge. The degree in which the mould board shall curve, and hang over at H, for turning the furrow slice, may be varied according to the judgment of the maker, the curvature being governed by the diameter of the generating circle, and the degree in which the gauge is depressed at every successive application of it.

Having thus fully set forth the nature of our invention, and shown the manner in which we carry the same into operation, what we claim therein is the giving to our mould board the segment of a cycloid, convexly on its face in line leading from front to rear, and concavely in the lines of the ascent of the furrow slice, in the manner and for the purpose herein described.

SAMUEL WITHEROW,
DAVID PIERCE.

*Remarks by the Patentee.*—A principal object in ploughing is to pulverize the soil, and the only way in which this can be effected by the plough, is by bending the furrow slice on a curved surface, so formed as that it shall also twist it somewhat in the manner of a screw. Such a surface will be formed by taking a strip of iron and twisting it after the manner of a screw auger; and if there is given to this piece of iron a greater twist at one end than at the other, cycloidal curves may be thereby produced. Now as the curvature of the cycloidal mould board generally increases from the lowest to the highest point of ascent, it follows, necessarily, that the furrow slice in passing along it will be more and more bent as it ascends.

By forming the fore part of the mould board by means of that part of the cycloidal gauge which has the least curvature, and the hinder portion by that part which has the greatest, the bending of the furrow will continue, and be increased, as it passes horizontally, as well as in its ascent.

By forming the lines of ascent cycloidal concavely, and the horizontal lines cycloidal convexly, the twist in the mould board will gradually increase from the fore to the hinder part, as the curves contract, which will operate very advantageously in pulverizing the soil. The convex cycloidal form given to the horizontal lines will cause the furrow slice to leave the mould board in a direction well calculated to prevent it from falling off in segments. The advantages possessed by this mould board, as has been abundantly proved in practice, are, that it will run light, and that it will turn the furrow slice over in a connected sheet, well pulverized.

*Specification of a Patent for an improvement in the mode of preparing Indian Rubber for the Manufacture of various articles; granted to* CHARLES GOODYEAR, *of Boston, Massachusetts, Assignee of Nathaniel Haywood, February 24th,* 1839.

To all whom it may concern: Be it known that I, Nathaniel Haywood, of the town of Woburn, in the county of Middlesex and State of Massachusets, have made a new and useful improvement in the mode of preparing caoutchouc, gum-elastic, or indian rubber, for the manufacturing of various articles in which that substance is used, and I do hereby declare that the following is a full and exact description thereof.

Sulphur, it is known, is soluble in the essential oils, which also are the solvents usually employed for dissolving caoutchouc, the oil of terpentine being generally employed for that purpose. I take the essential oil, say oil of turpentine, and dissolve in it, by digestion, a portion of sulphur, generally using about a teaspoon full of sulphur, in flowers, to the quantity of oil of turpentine which is to dissolve a pound of caoutchouc; the exact proportion not being important, and that indicated being sufficiently near for practical purposes. With this solution I proceed as with the ordinary spirits of turpentine.

Instead of making this solution of sulphur, I sometimes use the flowers of sulphur, or sulphur in fine powder, and incorporate it in the proportion above indicated with the gum when brought to a pulpy mass by any of the common solvents, or when worked by heated cylinders without any solvents, taking care that it is intimately mixed with the mass. Another mode of using the sulphur is to apply it to the surface of the gum after it has been applied to the cloth, or rolled into sheets, causing it to adhere by pressure or otherwise. After which the gum is to be submitted to the action of metallic salts, in the manner described by Charles Goodyear in the specification of letters patent obtained by him therefor.

The effect of the sulphur, in whatever way it may be added to the gum. is to cause it to dry more perfectly, and to improve the whole substance thereof, rendering it much superior to that prepared by any other combination therewith. The subsequent process of curing, or tanning, the surface above referred to, as patented by Charles Goodyear, removes all the odour of sulphur, and is intended to be generally applied to all articles manufactured as above.

What I claim as my invention and desire to secure by letter patent, is the combining of sulphur with gum-elastic, whether in solution or in substance, in either of the modes above pointed out, or in any other that is substantially the same, and which will produce a like effect,

NATHANIEL HAYWARD.

## English Patents.

*Specification of a Patent granted to* HENRY PHILLIPS, *of Exeter, for his invention of certain improvements in purifying gas for the purpose of illumination.*—[Sealed 17th August,1835.]

The object of this invention is, to free coal gas from the ammonia which has such a corrosive effect upon all brass and copper fittings with which it

may come into contact. The method employed by the patentee for carrying this purifying process into effect, is by submitting the gas to the action of a saline solution, in the following manner:—

A suitable vessel, of a quadrangular shape, is fitted with a number of shelves peforated with holes, and upon these shelves is placed refuse tan, twigs, furze, pebbles, linen rags, or any other substances capable of retaining the saline solution for a time. Near the top of the vessel, and immediately below its lid, a perforated plate or shelf is placed, and covered over with a coarse linen cloth; this cloth is fastened to the plate by nails, which are driven through the holes, their points extending downwards for about an inch, or an inch and a half below the plate. The cover or lid of the vessel is then placed on and secured by a water joint so as to prevent any of the gas from escaping; the saline solution, consisting of alum, or any other suitable salt dissolved in water, is then admitted by a pipe, and allowed to run on the coarse linen cloth, the capillary attraction of the fibres will cause the saline solution to be distributed throughout its entire surface, and to drop down upon the tan, furze, twigs, or other substances on the shelf below. From thence the liquor continues dropping upon shelf after shelf, until it reaches the bottom of the vessel, whence it is extracted by means of an inverted syphon.

The gas to be purified is to be admitted at the lower part of the vessel, and allowed to rise through the tan, twigs, furze, or other substances upon the perforated plates or shelves, being subdivided in its passage, and obliged to enter into close contact with the saline solution, which deprives it of the ammonia.

When the gas has ascended to the upper part of the vessel through the coarse cloth, it is conveyed away by pipes in the ordinary manner; but if, upon testing the gas with litmus paper, it should be found that it has not been wholly deprived of the ammonia, it may, in like manner, be passed through another purifier similarly constructed.

The Patentee, in conclusion, says, that he lays no claim to the hereinbefore described apparatus separately, as it is constructed upon a similar plan to that employed in purifying gas by the dry lime process; he only claims it as being part of the apparatus by which his invention is carried into effect: and he claims more particulary as the invention secured to him by the present Letters Patent, depriving coal gas, employed for the purposes of illumination, of the ammonia contained therein, by passing the gas through, or causing it to enter into intimate connexion with saline solutions, as above described.

Lond. Jour. Arts & Sci.

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*Specification of the Patent granted to* Edmond Heuze, *of the County of Middlesex, for improvements in the Manufacture of Dextrine.* [Sealed September 27, 1838.]

The invention consists in the formation or manufacture or production of the substance known in chemistry by the name of dextrine, by means of the admixture and action of nitric acid, with and upon the farina of potatoes (usually called potato-starch) or the flour or starch of wheat, barley, or other appropriate farinaceous grain or seeds, and preparing such mixture as hereinafter described, whereby the same is converted into dextrine, at a much less expense, and in a state more serviceable for manufacturing purposes than by any means hitherto discovered. This operation may be per-

formed in different ways, but the following is the process which at present appears to me the best, and which I employ.

The farina, flour, or starch, being in a dry state, a portion of nitric acid of the specific gravity of about 1.4, equal in weight to one 400th part of the farina or flour, is mixed with such a quantity of pure water as is sufficient to wet the farina, flour, or starch, which is then carefully mixed with this fluid, so that every part of it may be wetted much as bread is mixed or kneaded.

It is not however necessary (though I think preferable) that the farina or flour of potatoes and similar substances, should be brought into a dry state, but it may be used as it is obtained by the maker from the tub or vat. In such case, a less portion of water will be required in the admixture of the nitric acid.

The paste thus formed is divided into lumps of any convenient size, say about twenty-five pounds weight, and these should be put to drain for a few hours, to allow any superfluous moisture to run off. The lumps should then be broken with the hands into small pieces, and placed in a chamber heated to any degree not exceeding 176 degrees of Fahrenheit, and kept there till perfectly dry (which at the heat of 176 degrees will be done within twenty hours), and they are then reduced to the state of flour, by pounding or grinding, and the use of a bolter or sieve; and this flour is then placed in an oven heated to from 212 to 248 degrees Fahrenheit, where it is kept till thoroughly dry. The time necessary for this purpose will vary according to the degree of heat, from about a quarter of an hour to five minutes: the lower the degree of heat within the prescribed limits, the dextrine will be the whiter, which is advantageous.

When wanted to be used for any of the purposes which I shall presently describe, the dextrine thus obtained is to be mixed with water, either cold or hot. The proportion of water varies according to the consistence of the liquor required, which differs for different purposes. The product is a gummy or gum like liquor, similar to the solution of gum-senegal in water, and its principal uses are as a substitute for that gum.

The most general object for which the dextrine is used, is a substitute for the solution of gum-senegal and other gummy or gum like substances, in printing and dressing silk, cotton, linen, and other fabrics; in painting or printing paper-hangings, in all sorts of distemper painting, in stiffening the different fabrics which require it, such as gauze, and in all the preparations which required formerly the use of starch and calcined starch, calcined farina, or British gum; also in the preparation of adhesive plaisters and bandages for surgical purposes, in glazing visiting cards and other papers: in short, it is a perfect substitute for gum-senegal and other gummy and gumlike substances, in all processes of this nature with which I am acquainted, while it is much cheaper than any of them.

Any heated chamber and any oven in which heat can be obtained at the degrees mentioned above, will answer the above purposes.

I wish to observe, that I do not confine my invention to the particular process or preparation, or mode of mixing which I have above described. These are merely pointed out as the most convenient methods that I have discovered of employing my invention, which is the use of nitric acid mixed with water and farinaceous vegetable matter, and exposing it to the degrees of heat stated, so as to thereby produce dextrine—but I do not claim as new, or of my invention, the application of dextrine to the processes I have above mentioned, or any other.

Rep. Pat. Inv.

*Specification of a Patent granted to* GEORGE HADEN, *of the County of Wilts, for Improvements in the Manufacture of a Soap or Composition applicable to the Felting, and other Processes employed in the manufacture of Woolen Cloth, and other Purposes for which Soap is usually employed.*—[Sealed October 8, 1838.]

My invention relates to the application of castor-oil, in substitution of the oils and other fatty matters heretofore used in soap making, whether for the processes of manufacturing woolen cloth or other purposes. The various modes of manufactoring soap being well known, and as my improvement by the application of castor-oil, does not interfere with such processes, it will not be necessary to enter into any particular description thereof, and the soap-maker will, as heretofore, vary the materials compounded with the castor-oil, according to the object he desires to attain.

I have found that the mixing at the rate of five cwt. of castor-oil with the caustic leys produced from one hundred weight of salts of soda, produces a very good quality of soap, when boiled and treated in the usual manner of soap boiling. I would, however, remark, that I do not confine myself to any particular quantities, nor to any particular matters which are to be mixed with castor-oil in the making of soap, as they will necessarily vary, as heretofore, in making soap from oil or other fatty matters.

The plant which produces the castor bean is well known to be very productive, and will grow freely in the colonies of the British crown, particularly in the West Indies, and will become extensively in demand when soap is made therefrom, and may be produced and brought to England at a very low cost, and render this country independant of foreign produce. And I would have it understood, that what I claim as my invention is the application of castor-oil in substitution of the oils and other fatty matters heretofore employed in soap making. Ibid.

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*Specification of a patent granted to* OGLETHORPE WAKELIN BARRATT, *of Birmingham, in the county of Warwick, for his invention of certain improvements in the process of decomposing muriate of soda for the manufacture of mineral alkali and other valuable products.*—[*Sealed 19th January*, 1839.]

In the common method of manufacturing sulphate of soda by decomposing muriate of soda or common salt with sulphuric acid and exposing the mixture to a strong heat in a furnace, muriatic acid gas is disengaged and is with difficulty condensed. Now the objects of these improvements in the said manufacture are the following:—Firstly, to effect the decomposition of the common salt without the application of heat and without the escape of muriatic acid gas, and which improvements are effected in the following manner:—

To about one hundred and thirty parts by weight of common salt dissolved in four hundred parts of water, add one hundred parts of concentrated sulphuric acid, and to this mixture put in sixty parts of metallic zinc in pieces of moderate size; on adding the zinc hydrogen gas is evolved or given off, which gas is to be collected in the usual way in any of the well-known apparatus for collecting and burning gases. The hydrogen gas so collected may be burnt and applied to the purposes of evaporation, or to any other purpose where light or heat is required.

When the zinc is dissolved, and time allowed for the sulphate of soda to form, or crystallize, draw off the clear supernatant solution, which contains chloride of zinc and a portion of sulphate of soda: then subject this solution to the action of heat, and by evaporation and cooling the remaining portion of sulphate of soda crystallizes, which is then added to the first crop. After this, wash the sulphate of soda in a hot saturated solution of common salt, which separates any chloride of zinc which may have remained mixed with the sulphate of soda.

In the above process it is evident that no heat is employed in the decomposition of the common salt, and that no muriatic gas escapes during such operation.

The object of the second process is to collect a portion of muriatic acid gas evolved from the mixture of muriate of soda and sulphuric acid when first brought together in a cold state, and then to finish off the charge or complete the decomposition of the salt and form the sulphate of soda by continuing or carrying out the process hereinbefore described. In this second process or operation an apparatus is employed suitable for the purpose—that known by the name of Woulfe's apparatus will answer very well.

To one hundred and thirty parts of common salt add one hundred parts of concentrated sulphuric acid. The vessel containing the salt and acid must be so constructed as to admit of the mixture being occasionally stirred with any convenient instrument or agitator, as a rake to facilitate the decomposition of the common salt, that portion of muriatic acid gas which is wished to be collected, being taken up by the water in the Woulfe's apparatus, in the form of liquid muriatic acid.

When muriatic acid gas ceases to evolve, and before the vessels are unluted, add to the charge of salt and acid four hundred parts of water; then remove the vessels containing the liquid muriatic acid, and add to the charge sufficient zinc to complete the decomposition of the common salt.

The quantity of zinc required for this purpose will be found to be about one third less than in the first process.

The hydrogen gas evolved from the mixture or charge is to be collected and applied; then crystallize the sulphate of soda and proceed as already described.

The solution of chloride of zinc obtained in the above-described processes is to be decomposed by means of any convenient agent so as to separate the oxide of zinc. The patentee has found lime to answer this purpose with the greatest economy: sixty-four parts of zinc dissolved will require for this purpose about fifty-six parts of lime of the best quality and reduced to the state of cream of lime by slacking and mixing with water; but if after the addition of this proportion of lime the solution should by the well-known tests appear to contain excess of acid, more lime must be used till it ceases to do so.

The oxide of zinc thus precipitated is to be washed with a large quantity of water, to free it as perfectly as possible from chloride of calcium: it may then be used instead of metallic zinc for the purpose of decomposing fresh portions of common salt.

The patentee says he would remark, that the oxide precipitated from the solution of chloride of zinc, containing sixty-four parts of the metal, being used instead of the same quantity of metallic zinc, a little allowance should be made for the loss unavoidable in the process. Or the oxide may be employed as a pigment, or in the manufacture of glass, or for any other purpose to which it is applicable.

It will be evident that the native carbonate of zinc and also sulphate of zinc may be used instead of metallic zinc and the above-described oxide of zinc; but they have not been found to be so advantageous under common circumstances—still he claims their use as part of his invention.

The patentee says, in conclusion, "I wish it to be understood that I do not confine myself to the use of any particular apparatus hereinbefore mentioned; nor do I claim any privilege with respect to such apparatus, nor the preparation of the muriatic acid. And I do not claim lime as a precipitant of zinc, nor the producing hydrogen gas from the decomposition of water. But I claim as my invention the use and application of zinc in any form in the decomposition of common salt, and in the manufacture of sulphate of soda; I also claim as my invention the producing of hydrogen gas during the decomposition of muriate of soda; and lastly, I claim as my invention the chloride of zinc as produced during the decomposition of muriate of soda. And I would remark, that I do not intend to confine myself to the proportions here stated, as other proportions may be used, but not with such advantage."

Lond. Jour. Arts & Sci.

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*Specification of a patent granted to* MILES BERRY, *of the county of Middlesex, for an invention of a new and improved method or process of alloying metals by cementation, particularly applicable to the preservation of copper, wrought or cast iron, and other metals; thereby operating a change in the appearance of their surfaces and giving them more brilliancy; being a communication made to him by a foreigner residing abroad.*—[*Sealed 3d May*, 1838.]

Alloying or changing of metals by cementation is a process well known in metallurgy, but I am not aware that any metal has ever been before so changed or protected by this process, that it could resist the action of air or humidity, or of certain acids; whereas, copper and iron, both wrought and cast, and other oxidizable metals, when they have been subjected to the said process, according as the same is modified to suit each particular description of metal, will be found to resist all these sources of oxidation.

And first, as regards copper, after it has been well cleansed, it is placed in a furnace, covered with a mixture of charcoal and powder of zinc, and the temperature then raised to cherry red, which degree of temperature is kept up for a longer or shorter period, according to the bulk of the article, or to the desired thickness of the coating and color to be given to the article. The operation is one of great nicety, for which I am informed no definite rules can be laid down, but, that experience will enable any competent workman to effect it with sufficient exactness. It will be found, that in every case, there is a point at which the copper when taken out of the furnace is perfectly inoxidizable, whereas, if the operation lasts too long, the product is nothing but common brass, very readily oxidized.

Second, with respect to iron: for the protection of this metal, two parts of zinc and three parts of copper are melted together in a crucible or any other suitable vessel, and into this mixture or alloy, the piece of iron after being well cleaned, is plunged. If bulky, the article is heated before it is dipped into the crucible, and the better to exclude the atmosphere, the zinc and copper bath is covered with a layer of sal-ammoniac, or melted rosin, or borate of soda, or other suitable substance, preferring however, the sal-ammoniac, which is found in practice to answer better than any other interposed medium.

The process thus described is occasionally reversed, that is to say, a boiling solution of the sal-ammoniac, or of borate of soda, is prepared, and the iron dipped therein before immersing it in the zinc and copper bath, but I am not advised to recommend this process as preferable to the other.

The article being prepared by one or other of these methods, is put into a layer of charcoal powder in a furnace, and exposed to a strong red heat, until the fumes of zinc begin to abate. It is not well to wait until the vapours indicate no longer any zinc. The quicker the operation, the better is the result. The piece of iron must be taken out of the furnace still covered with charcoal, and in that state plunged into water, or allowed to cool slowly.

A third modification of the process is as follows:—an alloy is made of zinc and copper in the proportions aforesaid, namely, two parts of zinc to three parts of copper, and when cooled it is put into a mortar with a quantity of borax, and pulverized. The iron well scoured and cleaned, is then smeared over with fat, oil, grease, or other unctuous substance, or merely wetted with water, and when thus prepared it is dipped into the zinc and copper powder, whence it is taken to be plunged into charcoal powder, and subjected to a strong red heat as hereinbefore directed, until the fumes of zinc begin to abate.

A fourth variety of the process is to dip the iron into a solution of sulphate of copper (after being perfectly cleaned), and to suffer it to remain there for a time. As soon as the iron is covered with a sufficient coating of precipitated copper, it is taken out, plastered over with potters' earth mixed with water, and then covered with a layer of pulverized zinc and borate of soda, or other substitute for the same; or the pulverized zinc and borate of soda or other substitute may be made into a paste, with the clay and water, and the article smeared over with the said paste. The iron is then placed in the furnace, covered with charcoal powder, and heated to a white heat for some minutes. The rest of the process is the same as before described.

The metals thus rendered inoxidizable, are either of a gold or silver hue, according to the length of the operation or the quantity of zinc that combines with the copper. The brightness of the gold colored alloy may be enhanced by rubbing the article with vegetable charcoal, or the soot from a wood fire and nitric acid. It is proper to add, that instead of pulverized zinc, I have been informed pulverized calamine may be used.

And having now fully specified all that has been disclosed or is known to me of the said process, I declare that I claim as new the process of alloying by cementation as hereinbefore described in its several varieties, by which copper, iron, and other oxidizable metals are preserved from oxidation, their surfaces are changed in appearance, and also rendered more brilliant.

Ibid,

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*To* ORLANDO JONES, *of the county of Middlesex, for improvements in the manufacture of starch, and the converting of the refuse arising in or from such manufacture to divers useful purposes.*—[*Sealed 27th February*, 1839.]

These improvements in the manufacture of starch and in the converting of the refuse arising in or from such manufacture to divers useful purposes, consist in the following modes of operating:—

Firstly, I have discovered that the introduction of saccharine matter among the farinaceous materials employed in the manufacture of starch is beneficial in promoting the vinous fermentation; secondly, that the introduc-

tion of yeast or other ferments among the materials in such manufacture will also assist the vinous fermentation; and thirdly, that acetic acid may be usefully employed for dissolving and separating the gluten from the fecula in starch-making.

Though saccharine matters obtained from various substances would answer the purpose of my improved process, yet I prefer that obtained from the wash or refuse slime resulting from the manufacture of starch, which I prepare in the manner hereinafter described, and apply it with the meal, flour, or farinaceous material, whilst they are undergoing the steeping process. Yeast or other ferments may be added to the meal, flour, or other farinaceous materials, when steeping in the vat, the liquor being at a temperature of about 65° Fahrenheit. The acetous acid, in whatever way produced, I apply either by steeping the meal or flour in it in the first instance, which will supersede the necessity of a subsequent vinous fermentation, or it may be applied after the vinous fermentation has ceased, for the purpose of dissolving and separating the gluten from the meal, flour, or other farinaceous materials.

In order to convert the refuse wash or slime into saccharine matter or sweet liquor, I boil the said wash or slime with acid in the following proportions, or nearly so:—To any given quantity of the wash or slime, I add from one-twentieth to one fortieth by measure of the ordinary sulphuric acid of commerce, according to the state of the wash, which can only be known from observation. Such mixture I boil from two to four hours, dependent upon the strength of the acid and the state of the wash; and after this has been done, I introduce as much chalk or lime, or other suitable alkali, into the liquor as will neutralize the acid, and when settled, draw off the sweet liquor, which is then fit for use. Or I warm one hundred gallons of the before-mentioned wash or slime in a vessel to the temperature of from 76° to 86° Fahrenheit, and add to this from two to four bushels of finely-ground malt, and after well stirring it, raise the temperature of the mixture to 150° or 160° Fahrenheit. In this state it must continue from one to two hours, when the sweet liquor may be drawn off for use.

This saccharine matter or sweet liquor, thus obtained from the manufacture of the starch, I apply to promote the vinous fermentation in starch-making. Or the same may be fermented into distillers' wash, and subjected to the process of distillation for the production of alcohol; or it may be allowed to pass into the acetous fermentation, and be converted into vinegar.

Also, the top liquor resulting from the vinous fermentation of the meal, flour, or other farinaceous materials in the manufacture of starch, either in the improved or the ordinary mode, may, when the vinous fermentation has ceased, be drawn off for distillers' wash; or it may be allowed to pass into the acetous fermentation, and be converted into vinegar.

More particularly to describe my improvements in starch-making, without intending to confine myself precisely to the quantities of the materials used, I will say, for example, take four hundred gallons of water and add eighty gallons of sweet liquor, and warm the whole, and when at 65° F. stir in one hundred bushels of meal, flour, or other farinaceous materials; to this add from ten to fifteen gallons of yeast, or any other fermenting matter sufficient to set it in active fermentation; then stir it, that the whole may be equally fermented; and when the vinous fermentation has ceased, draw off the top liquor, from which may be extracted the spirit by distillation, and add four hundred gallons of strong acetic acid to the meal, flour, or other farinaceous materials remaining after the top liquor has been drawn off.

Stir this occasionally for three or four days; then wash it through sieves into a receiver, using acetic acid or water for that purpose; it must then be allowed to deposit, and after drawing off the acetic acid, separate the slime or wash from the starch, which may be washed and finished in the usual way of starch-making.

Should the slime or wash still contain starch, add acetic acid, and well stir and allow it to deposit; after which, the slime or wash should be drawn off, and the starch finished as usual.

Or I may vary the process, by taking four hundred gallons of acetic acid, cold, or warmed to 65° Fahr., and add one hundred bushels of meal, flour, or other farinaceous material, and stir it well occasionally for two, three, or four days, after which it may be washed through sieves and finished as above. Again, I may vary the process by taking four hundred gallons of water, cold, or at 65° Fahr., and adding one hundred bushels of meal, flour, or other farinaceous material, and allowing it to remain till the vinous fermentation has ceased: then draw off the top liquor (from which may be extracted the spirit by distillation), and add to the meal, flour, or other farinaceous material remaining after the top liquor has been drawn off, four hundred gallons of acetic acid warmed to 65° Fahr., or cold, and stir it well together. After remaining from two to four days, I wash it through sieves and proceed as already described.

Having thus explained my improvements in the manufacture of starch, and in the converting of the refuse arising in or from such manufacture to divers useful purposes, in such a way as I think will be perfectly understood by starch-makers, I lastly declare, that the novelties which I claim to have invented in respect to such improvements are, firstly, the introduction of saccharine matter among the meal, flour, or other farinaceous materials employed in starch-making, to promote fermentation and expedite the process; secondly, the employment of yeast or other ferments for a similar purpose; thirdly the use of acetic acid, to promote the acetic fermentation and to dissolve and separate the gluten in the process of starch-making; fourthly, converting the wash or slime obtained as a refuse product from starch-making to the purpose of producing a sweet liquor, which may be employed for the making of sugar and other uses, and particularly for promoting the vinous fermentation of the meal or flour in starch-making, or as a wash from which alcohol may be distilled; or it may be subjected to acetous fermentation, and converted into vinegar; and fifthly, the top water which is obtained from the vinous fermentation of the meal or flour, and the employment of the same as a distillers' wash for the production of alcohol, or for manufacturing acetic acid. Ibid.

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## Progress of Practical and Theoretical Mechanics and Chemistry.

### *Heath's Improvements in the Manufacture of Iron and Steel.*

Mr. Heath's invention consists, first, in the extraction of pure cast iron from the ore, without the intervention of any earthy, alkaline, or saline matter, to form a vitreous flux, cinder, or slag; second, in producing cast steel by fusing the pure cast iron so obtained, along with malleable iron or certain metallic oxides, in such proportions as may decarburate the cast iron to a certain degree; and in carrying the process of decarburation to the farther extent desired, by cementation with metallic oxides, without any admixture

of carbonaceous matter; third, in the use of oxide of manganese, without mixture of any other substance, in the process of converting cast into malleable iron, by the process of puddling; and, fourth, in the use of carburet of manganese to make common blistered steel into cast steel.

Malleable iron is at present produced either by smelting the richer iron ores with just as much charcoal or other carbonaceous matter as is adequate to abstract all the oxygen from the ore, and bring the ore into the malleable state; or by smelting the poorer ores, called "iron stones," in contact with carbonaceous matter, in such excess as to form with the metal the compound called carburet of iron by chemists, and cast iron by manufacturers; and then separating the carbon by a distinct and subsequent process. By the first process, malleable iron of very unequal quality in its different parts is produced; and by the second process a cast iron is obtained, which is contaminated to a very considerable degree with sulphur, phosphorus, arsenic, silicon, aluminum, calcium, and other foreign substances. A pure native oxide, or carbonate of iron, is alone capable of producing a pure metal convertible into good steel; but such pure ore has been hitherto debased and deteriorated in the smelting, by mixture with earthy, saline, or alkaline matters, under the name of fluxes, added with the intention of promoting the reduction of the metal, and of protecting it when reduced from the oxidizing influence of the blast.

After an extensive course of experiments, Mr. Heath has discovered that such earthy fluxes are not necessary. His operation is commenced by charging the blast furnace successively with coke, charcoal, or other suitable fuel, leaving the tap hole open, that the flame of the fuel, urged by the blast, may play in all directions, so as to bring the whole interior of the furnace into a uniform state of incandescence. When the furnace is thus charged, the tap hole is closed, and 20lbs. of ore are thrown into the furnace for every 100lbs. of fuel. The furnace is charged at this rate for about twelve hours, when the melted metal is run off into pigs. After this first discharge or casting the ore is added at the rate of 25lbs. for every 100lbs. of fuel, for a second period of twelve hours, when a second casting of pig iron is run off. After this second discharge, ore is added at the rate of 30lbs. for every 100lbs. of fuel during a third working period of twelve hours, and thus in each successive period of twelve hours, the quantity of ore is increased at the rate of five per cent. of the weight of the fuel, till eventually the proportion of ore amounts to about 65lbs. or 70lbs. for every 100lbs. of fuel. By proceeding in this way, and by throwing in the ore merely reduced to the size of peas, or thereabouts, but not roasted, if the furnace be well attended to by the workmen, it will turn out about 50lbs. of pure pig iron for every 100lbs. of fuel consumed.

To convert the carburet or cast iron thus produced into steel of any degree of hardness, it is melted in a cast iron or cupola furnace, by the heat of coke or other fuel; but, in all cases, no more fuel is used than is requisite to melt the iron, so that the oxygen of the blast shall serve to burn away the carbon of the carburet in a considerable degree, while a further portion of the carbon is neutralized or removed by the addition of scraps of metallic iron, or by the oxides of iron or of manganese.

To produce a superior cast steel from the pure cast iron, sesquioxide of manganese, or peroxide of manganese, which has been previously ignited, is introduced in quantities not exceeding five per cent. into the cupola: no more fuel is used than the blast can readily burn into carbonic acid, otherwise the excess of the carbonaceous flux would deoxidize the manganese,

nullify its decarburating action upon the cast iron, and thus prevent it from reducing the metal to that lower stage of carburet which constitutes cast steel. Sometimes, for the same decarburating purpose, a portion, not exceeding five per cent., of chrome ore may be used. When the decarburation has been carried in the cupola to the proper pitch, the steely metal is to be run out, and cast into iron moulds. The ingots thereby formed, are now to be converted into steel of any desired degree of mildness, by a further process of decarburation, which consists in stratifying the said ingots along with peroxide of iron, or peroxide of manganese, without charcoal, in in a steel cementing furnace, which should be lined with sheet iron, if it is constructed of fire brikes or stone, to prevent the action of the peroxides upon the stone or bricks of the furnace. The ingots are to be here subjected to a cementing heat for a certain period, proportional in duration to the softness required in the metal.

Mr. Heath further improves the quality of malleable or bar iron, by adding to the pig or plate iron in the puddling furnace, while in fusion, from one to five per cent., or thereabouts, of any pure oxide or manganese, the sesquioxide being preferred.

An improved quality of cast steel is made, by putting into a crucible bars of common blistered steel, broken as usual into fragments, along with from one to three per cent. of their weight of carburet of manganese, and exposing the crucible to the proper heat for melting the materials, whi[illegible] are, when fluid, to be poured into an ingot mould in the usual manner.

London Mech. Mag.

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*Destructive Combination of Iron and Lead. By* W. A. Kentish.

There is not a square, and scarcely a house that is not surrounded with iron railings, and these are pretty universally fastened in at the lower extremity, by *lead*. This combination of *iron and lead* keeps up so strong a *galvanic* action through the medium of the oxygen of the air, that the rails are, in a very moderate time, eaten away at the junction of the two metals, which must yearly entail an enormous loss that might easily be prevented.

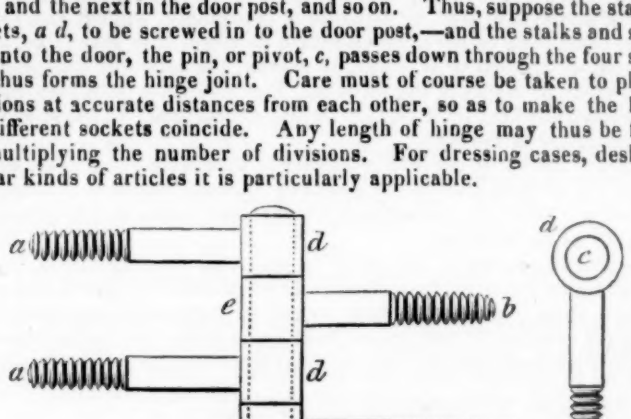
The *iron*, in this instace, becomes the *protecting* metal, and thus *preserves the lead from decomposition*, which never could have been originally contemplated.

Now, if instead of using the lead, which is thus thoughtlessly rendered an inveterate enemy to the rails, we were to substitute *zinc*, for instance, this galvanic influence would then become *inverted*, the whole of its action would fall on the *zinc*, and the iron would be *preserved*, and as the zinc is oxidated with difficulty, it would, at the same time, be scarcely acted on; the one remaining uninjured, and the other nearly so.

*Paint*, formed of the *oxide of zinc*, for the same reason, would preserve iron exposed to the atmosphere, infinitely better than the ordinary paint which is composed of the *oxide of lead*. In some instances of late years, iron covings have been used instead of stone. The rails are inserted in a square hole that just fits the bars, the unsightly method of filling up with lead is avoided, and all parts of the iron expand and contract equally in heat and cold. Whereas, with stone, the humidity in winter insinuates itself into the cavities round the fittings, and as it freezes, and so increases in volume, it bursts the stone covings in all directions. Ibid.

### *Edward's Improved Hinges. Patent dated April* 3, 1839.

This is a very neat and ingenious improvement upon the ordinary hinge. The hinge is divided into a number of socket joints, each socket or division having a stalk attached thereto, or forming one piece therewith, by which to fix it to the door or door-post,—lid or box, for which the joint is to be formed. The sockets, or divisions, are to be fixed (either by screwing them in, or putting them through holes and tightening with a nut,) alternately one in the door, and the next in the door post, and so on. Thus, suppose the stalks and sockets, *a d*, to be screwed in to the door post,—and the stalks and sockets, *b e*, into the door, the pin, or pivot, *c*, passes down through the four sockets, and thus forms the hinge joint. Care must of course be taken to place the divisions at accurate distances from each other, so as to make the holes in the different sockets coincide. Any length of hinge may thus be formed, by multiplying the number of divisions. For dressing cases, desks, and similar kinds of articles it is particularly applicable.




The specification describes various methods of fixing the sockets, and some modifications of the hinge to suit particular cases, but the foregoing explanation fully exemplifies Mr. Edwards' invention. Ibid.

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### *Pattison and Losh's Mode of Making Oxides of Lead and Antimony. Patent dated April* 3, 1839.

Messrs. Pattison and Losh state their invention to consist in producing oxides of lead and antimony by first reducing these metals to the state of chlorides.

The broken lead ore is to be put into a wooden vessel lined with lead, then muriatic acid, of the strength of 1.10, is to be poured thereon. The vessel is closed air-tight—and the heat of steam applied until the whole of the ore has been reduced to the state of chloride of lead. The sulphuretted hydrogen evolved in this process, when sulphuret of lead is operated upon, is to be conveyed from the vessel by a pipe or other suitable means. The chloride of lead is then to be dissolved in hot water, and lime, cream of lime, or other earthy matter, is to be thrown into the solution, by which the oxide of lead will be precipitated: about 60lbs. of unslaked lime are necessary to 100lbs. of chloride of lead. By this process the sulphur of the ore is obtained in a state fit for use. Where the oxide is to be used as "blue lead," it must be submitted to the action of heat in a reverberatory furnace as with the oxide obtained by the usual process.

Antimony is to be treated in a similar manner to that described for lead. The chloride of antimony having been obtained, and dissolved in water, antimony itself will be precipitated; or if oxide is desired, about 60lbs. of unslaked lime is necessary to every 90lbs. of chloride of antimony. Ibid.

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*Important Invention in the Manufacture of Paper Hangings.*

We were favoured a few days since with an opportunity of visiting the extensive paper works of Messrs. J. Evans and Co., at the Alder Mills, near Tamworth, where we had the pleasure of witnessing the application of an ingenious and very beautiful piece of mechanism, the invention of the Messrs. Evans, to the printing of paper hangings, which cannot fail to produce a complete change in this department of our manufactures, from its superiority over the ordinary method of block printing. The Messrs. Evans would have brought their invention into practical operation many years ago, had it not been for the heavy duties imposed on the manufacture of stained papers, which, by limiting the consumption, rendered their invention comparatively useless, a fact which supplies another argument against the imposition of heavy duties upon the manufacturing skill and industry of the country. In connection with the present invention, we may here state that the Messrs. Evans took out a patent in February last, for an important improvement in the manufacture of paper, by the application of a pneumatic pump in the compression of the moisture from the pulp, by which means the substance is almost instantaneously converted into paper. By this invention they are, we understand, enabled to manufacture a continuous sheet of paper six feet in width, and nearly 2,000 yards in length every hour. This paper, as it is taken off the reel, is in every respect fit for immediate use, and is conveyed on rollers to another part of the mill, in which the printing machinery is erected, through which it is passed with great rapidity, and receives the impression of the pattern intended to be produced, with all the precision and beauty of finish which machinery can alone effect. In order to connect the operations of the paper making and printing machines, the Messrs. Evans are at present engaged enlarging their premises, and when this alteration is completed they will be enabled to print, glaze, and emboss, the most complicated and delicate patterns in paper hangings, in every variety of shade or colour, as rapidly as the paper can be manufactured. Some idea may be formed of the power of the machinery, and the importance of the invention, when we state that during our visit to the mill, the machinery was working at a rate which would produce 1,680 yards of paper per hour, consisting of two very beautiful patterns, the only hand labour employed being that of one man. who superintended the machinery, and four girls, employed in rolling up the paper in pieces of the required length. The whole process of manufacturing the paper from the pulp and impressing it with the most complicated patterns, is carried on within a comparatively small space, and with a precision and rapidity which affords another instance of the progress and triumph of science and mechanical skill, in supplying the necessaries and comforts of civilized life. We understand it is the intention of Messrs. Evans to exhibit some specimens of their beautiful manufacture at the forthcoming meeting of the British Association, and we feel confident that amongst the many objects of interest which the mechanical skill and industry of Birmingham afford, the present will excite not the least interest or gratification. We may, perhaps, here observe, that the Messrs. Evans have also executed a very ingenious design of an envel-

ope, which seems admirably adapted for meeting the views of government in the contemplated change about to be made by the adoption of Mr. Rowland Hill's plan of a uniform penny postage. Specimens of this design have been forwarded to the Chancellor of the Exchequer for examination, and from the security which it affords against any successful attempt at forgery there appears great probability that it will be in part, if not wholly adopted.

*Midland Counties Herald.* Civ. Eng. and Arch. Jour.

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### *Connexion of Geology with the Arts.*

We extract the following passages from the "Report of the Council of the Royal Institution of South Wales," recently published, and obligingly forwarded to us:—

"In reviewing the transactions of the year which has just expired, there is a subject, which it gives the council much pleasure to place before the meeting, namely, the recent establishment of a scientific intercourse with an institution of a very important description, powerfully promoted by the government of the country, which has sprung into existence in the metropolis, under the title of 'The Museum of Economic Geology.' The immediate aim of this establishment is to make the researches of philosophy available to the pursuit of the useful arts. The foundation of it is well worthy the support of an enlightened nation, and, under proper management, it cannot fail to become the source of valuable information to commercial enterprise, and a school of instruction in all those branches of industry, on the healthful growth of which the happiness and prosperity of this great kingdom mainly depend. To the inhabitants of a mining and manufacturing district its importance readily suggests itself, and they naturally become anxious to participate, with as little delay as possible, in the benefits it will yield. Influenced by a desire to make these available to their own institution, the council addressed to Mr. De la Beche (who, under the direction of the Commissioners of woods and forests, superintends the practical details of the museum in question), an expression of their sentiments on the subject, and they are happy to find that, from the intercourse proposed, advantages are likely to flow that will prove mutually beneficial. It naturally must happen that the opportunities of a well-regulated provincial institution will be ample in its own immediate neighbourhood, and in a district such as the southern part of Wales, which, for mineral wealth and manufacturing industry, yields to none, the facts that come before it, whether illustrative of the materials its mines produce, and its population work into form, or of the state and condition of the arts by which those materials are extracted from the earth and devoted to use, must be of considerable value to a society instituted for the purpose of applying science to the economic objects of life; while, on the other hand, the wide range and powerful means of the metropolitan society, bringing a collection of materials from a multitude of sources, will enable it to effect an extensive and instructive diffusion of the knowledge it obtains, and thus repay what it receives from one locality with the information it derives from another." Mining Jour.

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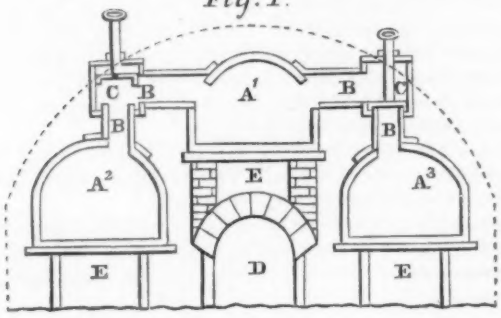
### *Barnett's Improved mode of working Gas Retorts.*

Sir,—I herewith forward you a description of a new mode of working gas retorts which I have had in successful operation here for some time. I shall

be much obliged by your publishing it in your Magazine, which has already distributed a great deal of information upon the subject of gas manufacture.

By adopting my improved method, about from 2,600 to 2,700 feet of gas, more than by the ordinary method, can be produced from a ton of coals, whatever the kind of coal may be. This increase of gaseous product is effected by the longer time which the material is kept subject to the influence of the heat, so that a great portion of the tar and ammoniacal water is decomposed. The gas produced is also of a greater illuminating power.

*Fig. 1.*




2.

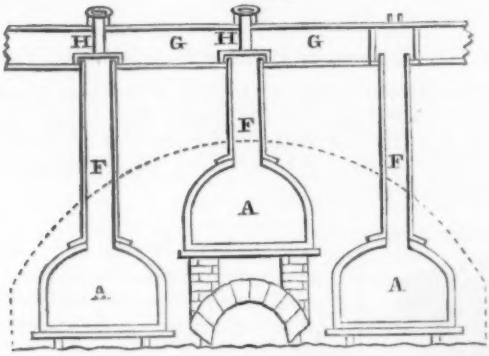



Fig. 1, is a sectional front view of a retort bed with three retorts. There may however be any desirable or convenient number. Fig. 2, is a sectional back view of the same retort bed. AAA are the retorts, which communicate with each other by means of the pipes B B B B. C C are two hydraulic valves, by which the communication between any two retorts may be cut off. Where three retorts are connected, two of them only need have valves —but where more than three are used every retort must have a valve. D, the position of the furnace, which communicates with the ovens E E E by means of small flues or apertures from the furnace. In fig. 2, A A A are also the retorts; F F F, the pipes leading to the gas main G G. This communication may be closed by means of the valves H H.

The mode of operation is as follows: The retort $A^1$ is charged; one hour and a half afterwards the retort $A^2$ is charged; and one hour and a half af-

ter that, the retort $A^3$ is charged; in one hour and a half more the retort $A^1$ is ready to be recharged; the coal having undergone the usual process of six hours subjection to the heat of the furnace; and so on in succession alternately, each retort being submitted to the action of the fire for the same time. In the retort $A^1$ (supposing the operation to be in full action,) the first hour and a half or quarter time of the charge, the dense volatile matter and ammoniacal water of the coal is set free, and passes into the retorts $A^2$ and $A^3$, where, in connection with the carburetted hydrogen which $A^2$ is producing, and the sulphuretted and carburetted hydogen which $A^3$ is producing, it is further distilled. Each retort will thus in succession be performing the stage of operation here represented. Previously to a retort being charged, its communication with the other, and with the main G must be cut off, by the valves C and H; and one retort only—that is to say, the one of the three (or any other series used) which has been longest subjected to the action of the heat,—must communicate with the main.

The figures are but roughly drawn, and all the parts except those relating to my improvement, are in skeleton. The exterior dotted lines represent the outline of the brick setting of the retort bed.

Should you think this invention of mine of sufficient importance for publication, I shall be happy to send you descriptions of other contrivances relating to the same subject, which I have at various times made, experimented upon and worked.

I am your obedient servant,

WM. BARNETT.

*Brighton, November* 15, 1839.

Lond. Mech. Mag.

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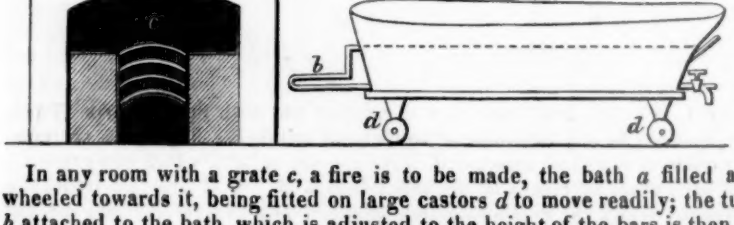
### *Economical Portable Hot Bath.*

Sir,—The following novel plan of heating a bath was communicated to me by Mr. Le Croix, of Upper Norton street, New Road, Regent's Park, whose idea it is; and thinking from its simplicity, it deserved being made public, I respectfully offer it for insertion in your valuable pages, if you think the plan merits a place in them.




In any room with a grate *c*, a fire is to be made, the bath *a* filled and wheeled towards it, being fitted on large castors *d* to move readily; the tube *b* attached to the bath, which is adjusted to the height of the bars is then inserted between them; in a short time the water will be heated to the degree required, when it may be wheeled to any part of the room without the least annoyance.

G. M. BRAITHWAITE.*

Ibid.

* We should be glad to receive from the readers of our Journal an account of any mode of heating a movable bath, which they may think preferrable to the foregoing. G.

## Progress of Physical Science.

*Experiments to determine the Fluency or Viscidity of Different Liquids at the same Temperature, and of the same Liquids at different Temperatures.* By Dr. Ure.

Having been employed professionally, Dr. Ure observed, to investigate the operation and merits of a new lamp, recently patented by Mr. Parker, in which the oil is heated by the flame of the lamp to the temperature of from 200° to 250°, before arriving at the wick, it was desirable to determine the degree of fluency imparted to oils by a certain elevation of temperature. The light emitted by this lamp, when supplied with the viscid, and very cheap, but nearly scentless, southern whale oil, surpasses in purity and whiteness the light of the best mechanical lamp, though it be fed with the best vegetable or even sperm oil. This superiority is in part due to the form of the chimney, and to the oil being maintained uniformly at the level of the bottom of the frame; but it must also be ascribed, in a certain measure, to the high temperature and fluency of the oil, by which it enters more readily into complete combustion, than cold and viscid oil could possibly do. The preparatory heating seems to act on the same principle here, as it does in the smelting of iron by the hot blast. Having presented a memoir upon the subject of the lamp to the Society of Civil Engineers, which will appear in their transactions, I shall decline entering at present further into its merits. In that memoir, I stated the results of some experiments which I had then made upon the fluency of liquids, by means of an apparatus, consisting of a small glass syphon, and a platina capsule, containing a measured quantity of the liquid to be run off through the syphon. Having since had reason to imagine that certain numerical errors had been occasioned by variations in the position of the syphon, though the general results are true, I have recently repeated the experiments with another form of apparatus free from that fallacy, and submit the following brief account of them. Upon this occasion I put the liquid, either cold or heated to a certain temperature, into a glass funnel, terminated at its beak with a glass tube of uniform bore, about one-eighth of an inch in diameter, and three inches long. The funnel was supported in a chemical stand, and discharged its contents, on withdrawing a wooden pin from the beak, into a glass goblet placed beneath, alongside of which a chronometer was placed to indicate, in seconds, the time of efflux. The volume of liquid used in each case was the same,—viz. 2,000 grain measure, at 65° Fahr. The times of efflux with liquids of the same specific gravity and bulk, in the same vessel, vary with the viscidity of the liquids, and serve to measure it. A correction ought to be introduced in estimating the times of efflux of hot liquids, on account of the enlargement, by expansion, of the bore of the glass tube; but this, being a point of little consequence in the practical application of this inquiry, has been neglected.

| | | |
|---|---|---|
| 2,000 grain-measures of water, at | 60° Fahr., ran off in | 14 sec. |
| | 68 | 13 |
| | 164 | 12 |

When the funnel and glass tube were faintly smeared with oil, though perfectly pervious, and apparently clean, boiling hot water having been run through them:—

| | | |
|---|---|---|
| 2,000 grain-measures of water, at | 150° Fahr., ran off in | 24 sec. |
| | 142 | 23 |
| | 94 | 24 |
| | 56 | 25 |

So great is the repulsive influence between oil and water, in retarding the flow of the latter through a small orifice.

| 2,000 grain-measures of | Fahr. | Spec. grav. | Sec. |
|---|---|---|---|
| Oil of turpentine | 65° | 0.874 | 14 |
| Pyroxylic spirit | " | 0.830 | 14 |
| Alcohol | " | 0.830 | 16 |
| Nitric acid | " | 1.340 | 13½ |
| Sulphuric acid | " | 1.840 | 21 |
| Ditto | 262 | | 15 |
| Saturated solution of sea salt | 65 | 1.200 | 13 |
| Sperm oil | " | 0.890 | 45½ |
| Fine rape-seed oil | " | 0.920 | 100 |
| Fine pale seal oil | " | 0.925 | 66 |
| Fine South Sea whale oil | " | 0.920 | 66 |
| Sperm oil | 254 | | 15 |
| Rape-seed oil | 254 | | 17 |
| South Sea oil | 250 | | 17 |

The rape-seed oil is so viscid, as to burn with difficulty in lamps of the ordinary construction, but in the hot oil lamp of Parker it affords a very vivid light. In my former apparatus, the difference of level between the two legs of the syphon, which constituted the effective pressure of efflux, was only half an inch, whereby 2,000 grain measures of sperm oil, at 64°, took no less than 2,700 seconds to run off, while that volume of oil of turpentine ran off in 95 seconds. It would, therefore, appear that the fluency of a viscid oil diminishes in a very rapid ratio with the diminution of pressure. Hence, an oil will burn well in a mechanical lamp, where it is raised to the level of the bottom of the flame by pump work, which will afford a very indifferent light in one of the French Annular or Sinumbral lamps, where the supply is given by a very slight pressure.

Prof. Forbes asked what was the diameter of the orifice of the funnel through which the fluids ran, and what was the quantity of each fluid experimented upon.—Dr. Ure said, that the orifice had a diameter of one-eighth of an inch, and the quantity of each fluid used was 2,000 grains.—Prof. Forbes said, that the interest he felt in these experiments arose from the great importance, in some of the researches he was engaged in, of sustaining the action of the lamp in an unchanged state during the progress of an experiment, and sometimes during a series of experiments; but the changes to which even the best ordinary lamp was subject were so anomalous, and the causes so beyond the reach of discovery, as to be quite disheartening. The instrument that he used for measuring minute changes of temperature was so delicate, that the heat given out by even an apparently well-burning lamp, often appeared to be in a constant state of change, the needle indicating it by an almost constant oscillating motion of even several degrees; even lamps, whose wicks were made with the greatest care, were subject to these changes; and the only wicks which he had found to furnish a sufficiently steady temperature for his purposes, were those made by Locatelli, of Paris.

Athenæum.

*Proceedings of the British Association. Divisibility of Matter.*

The President said, that as one or two papers had been withdrawn, he would proceed to make some remarks on Dr. Wollaston's argument respecting the infinite divisibility of matter, drawn from the finite extent of the atmosphere.—He observed, that Dr. Wollaston had proceeded on this supposition; that if the extent of the earth's atmosphere be finite, air must consist of indivisible atoms; since, as he assumed, the only way in which we can conceive an upper surface of the atmosphere is, by conceiving an upper stratum of atoms, the weight of which, acting downwards, is balanced by the repulsive force of the inferior strata acting upwards.—Mr. Whewell maintained, that such a mode of conception was altogether arbitrary, and the argument founded upon it quite baseless; for if we investigate the relation between the height of any point in the atmosphere, and the density of the air at that point, upon the supposition that the compressing force is as the *n*th power of the density, we find that the density vanishes at a finite height whenever *n* is greater than unity. Therefore, though the atmosphere do not consist of indivisible particles, it will still have a finite surface. In fact, the finite surface of the atmosphere no more proves the atomic constitution of air, than the finite surface of water, in a vessel, proves the atomic constitution of water. But it will still be asked, how then is the highest stratum of air supported? To which the answer is, that there is no highest stratum of definite thickness. Supposing the atmosphere finite, every upper stratum of air bounded by the upper surface of the atmosphere, has the upper part of that stratum supported by the lower; and, however thin it be, it has still an upper and a lower part which have this relation to each other. The question, What supports the *uppermost* stratum of the atmosphere? is of the same kind as the question formerly discussed by writers on mechanics: What is the velocity with which a body *begins* to fall?

Professor Stevelly said that perhaps this question would be more familiar to many persons if the scientific language of the President were made more popular, by explaining, that the real question was, whether matter was so constituted as to be infinitely divisible? or consisted of molecules or atoms, which could not be farther divided, *de facto* at least; for in imagination any portion of extension, however small, can be farther subdivided. This latter, Wollaston produced strong probable reasons for considering as the true statement; his argument from astronomy was, that if matter were capable of indefinite subdivision, the atmosphere would be indefinitely extended, and then the moon and planets would, each, in the lapse of time, have collected atmospheres from ours, bearing to one another the proportions of their power of attraction; this was not the case, as astronomy proved: for instance, the density of the atmosphere of the moon was not the 2000th part of that of the earth, at their respective surfaces. The earth's atmosphere then did not even extend, in space, as far as the moon.—Dr. Daubeny said he was sorry to find, that the doctrine of atoms, which on chemical grounds, he considered as probable, had been deprived, by the President, of the support which the memoir of Dr. Wollaston had seemed to afford it. He had been disposed to think more favourable of that argument, from finding that M. Dumas had resorted to a very paradoxical supposition in order to reconcile the conclusions of Wollaston, which he admitted, with the doctrine of the infinite divisibility of matter, which he also maintained. M. Dumas, in his work 'Sur la Philosophie chimique,' maintains, that a limit

would be assigned to the extent of our atmosphere in consequence, merely, of the extreme cold of the upper regions, by which the air would be condensed into a solid form. Hence, according to him, the boundary of the atmosphere would consists of a sort of *crystalline sphere*, such as what the ancients had imagined, but with this difference, that the celestial luminaries according to Dumas's views would lie beyond the sphere, whereas Ptolemy supposed them to be included within it. Leaving it for opticians to decide how far such a palpable medium could interfere with the transmission of light and heat from without, Dr. Daubeny contended, that the temperature which Fourier had assigned to the celestial spaces was too high to allow of the solidification of oxygen and nitrogen gases, which indeed had been found to resist a degree of artificial cold greatly inferior to this, as, for instance, that produced by solid carbonic acid. But though he could not agree with Dumas in this particular point, he was quite ready to bear his testimony to the general merits of his work, and in particular, to point out the satisfactory manner in which he has shown, that matter cannot be separated into its ultimate particles, either by physical or by chemical means; but that elastic bodies consist of *groups of atoms* mutually repulsive, and that chemical combination takes place between smaller groups indeed of the same, but not between individual atoms. Ibid.

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*On the Crystallization of Carburets.* *By* S. Brown, M. D.

The object was to lay down a new form of the maxim of crystallization —viz. That when the particles of a solid body are slowly evolved from the decomposition of a substance of which it, or its elements, are chemical constituents, they cohere in crystals, and that independently both of the fusion (or solution) of the body crystallized, and of the presence of any fluid medium or molecular motion whatsoever. This principle the author deduces from a multitude of experiments. The principle is applicable to substances which are infusible and insoluble; and, indeed, as the title of the paper imports, has been inferred from observations made on such substances—viz. the metallic carburets, as produced by the decomposition of sulphocyanides and cyanides. The subjects of the experiments were the carburets of iron, copper, zinc, lead, tin, manganese, &c. These carburets are, in their amorphous form, dark and opaque, being not easily distinguishable from charcoal. By the use of the following formula, the author prepares these substances in transparent, colourless, and intensly hard little crystals. Formula:—Let a parcel of any cyanide or sulphocyanide be decomposed by heat, in exclusion from air, at that point of temperature which may be called its point of decomposition, and the resulting carburet is found to be of crystalline structure. It is a tedious process, requiring five hours for a drachm of cyanide of zinc. The author exhibited specimens of crystals procured in this way, especially of carburets of iron, which cut glass. The application of these facts and their principle to the explanation of certain mineralogical and geological cases of crystallization, as well as to the arts, the author left with the Section; but called attention to that point of view in which his labours are chiefly valuable; that they prove that the only essential condition of the crystallization of a body is, that its particles be slowly segegrated from any previous condition whatever. In conclusion, he observed that the chemical identity of carbon and the diamond has been long established by inference. Now, there is as great a difference,—nay, exactly the same difference, between the

sensible properties of these carburets in their amorphous and crystalline conditions, as between the carbon of the destructive distillation of organic proximates and the *diamond*. The particles of carbon *may* be evolved from a matrix of which it is a chemical constituent; let them, in the terms of the general proposition, be evolved *slowly enough*, and they shall co-arrange themselves in the crytalline form of cohesion. In more pointed phrase, char wood with sufficient care, and you will obtain, not charcoal but crystallized carbon.

Athenæum.

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*Note on several new reactions determined by Spongy Platina, and considerations on the services this substance is required to render Science. By* M. Fred. Kuhlmann.*

Dœbereiner's beautiful discovery of the property which spongy platina possesses of determining the combination of a mixture of hydrogen and oxygen, has been justly regarded as one of the most precious facts acquired by science for a long time. Every one might forsee the extension that so extraordinary a kind of action would one day take, yet we are astonished at the few facts which have been observed since the date of Dœbereiner's labours, twenty years ago.

The numerous experiments, of which I am about to speak, appear to me likely to lead the attention of chemists to a too much neglected question, and which I look upon as the most fruitful in fine results.

1. Ammonia mixed with air, in passing to a temperature of 300° surrounding spongy platina, is decomposed, and the azote which it contains is completely transformed into nitric acid at the expense of the oxygen of the air.

2. Cyanogen and air under similar circumstances give rise to the same acid and carbonic acid.

3. Ammonia engaged in any saline combination acts as if it were free.

4. In no case has pure azote been able to be combined with free oxygen, but *every compound of azote under the influence of the spongy platina passes to the state of nitric acid.*

5. Protoxide and deutoxide of azote, hypo-nitric and nitric acid, mixed with a sufficient quantity of hydrogen, are transformed to ammonia by their contact with the platina sponge, and very often without the assistance of heat. The action becomes so energetic that it frequently causes a violent explosion.

All the azote of these oxides or acids passes to the state of ammonia by uniting with hydrogen.

An excess of nitric acid gives a nitrate of ammonia.

6. Cyanogen and hydrogen give ammonia in a hydrocyanate state.

7. Deutoxide of azote in excess and olefiant gas in becoming hot on the platina sponge, produce, besides water and azote, ammonia united to the hydro-cyanic and carbonic acids.

8. With deutoxide of azote and an excess of alcoholic vapour we obtain under the same circumstances ammonia united with hydro-cyanic and carbonic acids, and accompanied with water, olefiant gas, and a deposit of coal.

9. We have not been able to combine free azote with free hydrogen, *but all the compounds of azote have been transformed into ammonia by free or carbureted hydrogen.*

From the Comptes Rendus, 24th December, 1838. Translated by Mr. J. H. Lang.

10. In these latter reactions the presence of carbon in combination with azote or hydrogen, produces hydro-cyanic acid.

11. All the gaseous or vaporizable metallöides unite without exception with hydrogen under the influence of the spongy platina.

12. The vapours of acetic acid mixed with hydrogen are totally transformed into acetic ether (acetate of ether) and water, by the action of platina sponge at a slightly elevated temperature.

It is a very remarkable fact that by substituting the platinum black for the platina sponge, the energy of action is infinitely less in most cases, contrary to what we might expect. This action is even nullified for producing nitric acid; for producing ammonia it is very feeble, and the platina black never enters into incandecence as is the case with the sponge. For the tranformation of acetic acid into ether, the action of the platina black is, on the contrary, more lively, and produces it at the ordinary temperature.

Sturgeon's Annals.

## Progress of Civil Engineering.

*On the application of Anthracite Coal to the Blast Furnace, Steam-engine boiler, and Smith's fire, at the Gwendraeth Ironworks near Carmarthen. By* Mr. Player.

The inconvenience of the fire choking, for a long time baffled the experiments made on the subject, but it was at last obviated by heating the coal before it reaches the fire, which was accomplished by supplying it, without any mixture of coke or bituminous coal, through a perpendicular chamber placed centrally on the top of the boiler with an opening about 20 inches in diameter immediately over the fire-place. In passing through this chamber, by its contact with the plates, the coal acquires considerable heat, and descending by its own gravity, as the fire consumes beneath, replaces what has been burnt, by which means a regular supply of fuel is furnished, fit for immediate and complete ignition. Another inconvenience is also thus avoided, as fresh coal thrown upon the fire abstracts a quantity of heat from the fuel already in ignition, and checks the generation of steam. The fire is never meddled with; there are no fire drawers; there is no current of cold air passing through the flues, and a very small amount only of draught is required. One engine worked seventy-two hours consecutively, during which time the grate neither choked nor clinkered; nor was a bar used for the fire, or did there remain any considerable result in ashes. The coal was, in this instance, entirely anthracite, (small, but not powdery) and tipped into the feeding chamber once every 4 hours. Water was also kept in the ash pit, the steam from which, being decomposed by passing through the fire, the gas forms a jet of flame, creating another active source of power. On these works, there are in action upon this principle, five smith's fires, the toolmaker's fire being blown by a thirty inch bellows only, whilst with this the largest squaring edges for the masons are made with ease. The coal is supplied through an upright brick flue, about three feet six inches high, two feet six inches long, and nine inches wide. The foundry has similar arrangement, with merely the addition of a flue to take off the flame, the blast being cold, and worked by a small water-wheel, and by which iron is re-melted, running very fluid, and yielding an excellent quality. An oven has also been built for the use of the workmen, heated only with small culm, which succeeds admirably.

Athenæum.

*Proceedings of the British Association. On the relative Combinations of the Constituents of Cast Iron, Steel, and Malleable Iron. By* Dr. Charles Schafhaeutl, *of Munich.*

The author showed, that the purest carbon contained and retained hydrogen, and sometimes azote, even at the highest temperatures, and parted with neither of them, nor were its own internal and external properties altered, except when it attacked the crucible, and combined instead with oxygen, or aluminum, or silicon. He affirmed, that we possessed no certain method of procuring pure carbon in the isolated state, and that what we considered to be pure carbon was always, more or less, in the state of *carburet*. The author described a new method of obtaining graphite—viz. by running fluid puddling slag, or silicates of iron and manganese, over fragments of pit coal. After cooling, the surface of the slag is always found to be altered, and to be covered with a very easily separable layer of graphite, not only where the slag actually touches the coal, but even where it comes in contact with the smoke evolved from the coal. The formation of graphite commences at a temperature lower than 1500° Fahr., and reaches its highest point not much exceeding 2000°. Two different sorts of graphite were produced in this way; one, which he marked graphite (A), was in elastic scales, of the thickness of writing paper, with a rather dull metallic appearance. The graphite marked (B) was of the thickness of gold leaf, and extremely light and unctuous to the touch. He found, that all sorts of graphite lost their unctuosity and bright appearance by exposing them to the action of concentrated hydro-fluoric acid gas. Graphite (B) was found to consist of—

| | |
|---|---|
| Protoxide of iron, | 18.6000 |
| Silica, | 7.6200 |

Probably mechanically, but equally and invisibly intermixed with

| | |
|---|---|
| Carbon, | 70.3421 |
| Silicon, | 3.0744 |
| Loss, | 00.3635 |
| | 100.0000 |

Graphite (A) gave—

| | |
|---|---|
| 4.93 | Silicon. |
| 9.50 | Iron. |
| 85.45 | Carbon. |
| 00.12 | Loss. |
| 100.00 | |

The quantity of oxides of iron and silica had been ascertained by heating the specimens first with acids and caustic leys; the quantity of carbon, by burning the specimens with chromate of lead and chlorate of potash; and the silicon, by melting the powders with carbonate of soda in a platinum crucible. He considered, therefore, the graphite to be a *carburet of silicon* and iron; and showed, by heating in a *peculiar way* the remainders, left after the solution of iron in chlorohydric acid of a certain specific gravity, that the chemical composition of cast iron, in its two distinct species of gray and white cast iron, had direct relation to the two specimens of graphite, and in

all probability was derived from similar origin, as indicated in following table:—

| *Graphite (B).* | | *Gray Cast Iron.* | |
|---|---|---|---|
| Iron, Silicon, Silicon, Carbon | Oxygen. Silicate of iron. Carburet of silicon. | Iron, Silicon, (Aluminum) | Silicet and aluminet of iron. |
| | | Carbon, Silicon | Carburet of iron. |
| *Graphite (A).* | | *White Cast Iron.* | |
| Iron, Carbon | Carburet of iron. | Iron, Carbon, Azote | Carburet of iron. |
| Carbon, Silicon | Carburet of silicon. | Silicon, Carbon | Carburet of silicon. |

It was further shown, that all gray iron, produced by heated air, as well as by cold air, left a grayish white residue behind after treating it with chlorohydric acid of a certain specific gravity. This remainder, acted upon with caustic ammonia, evolved very rapidly pure hydrogen gas, and alumina afterwards was found in the solution with a little silica. The presence of aluminum in its metallic state, after having been treated with acid, as well as the absence of all *azote*, seemed to be one principal feature *of gray iron of France* as well as of England; as, on the contrary, carbon, hydrogen, and *azote* are always present in the remainders of *white iron*, which remainders appear invariably of a brownish colour; and that azote was a constituent of steel as well as of wrought iron. Further, it was explained, that silicon generally was combined with *carbon*, and dissolved in the carburets of iron, and that it was extremely difficult to produce an alloy of iron with silicon alone, without the presence of a little carbon, aluminum, and other similar bodies. He found the molecules of all iron of a similar form, belonging to the cubical system, and the largest not exceeding 0.0000633 of an inch in diameter, and that particularly upon the arrangement of these molecules depends, in a great measure, the different appearance of the different kinds. He denied that any graphite scales were to be seen in gray cast iron; yet, that under the magnifying glass what appeared to the naked eye graphite scales, were really surfaces and planes of crystallization, composed of pentagonal planes not wider in the smallest diameter than 0.000355 of an inch, and composed of the before-mentioned smallest or primitive iron molecules. According to his statement, the molecules of the iron are arranged in the gray cast iron in the most regular form, having all their surfaces in one plane; the most equal distribution of molecules appeared in hardened steel; collecting in fascicular aggregation in soft steel, and being loose and longitudinally arranged in wrought iron. He stated that pure iron could not be welded; that the welding power of iron depended on its alloy with the carburet of silicon, and also that the good and various qualities of all the wrought irons depended on the alloys of pure iron with other metallic bodies; and that the presence of most of the electro-negative metals had been generally overlooked in the existing analysis of iron. The presence of arsenic in Swedish steel, when forged red hot, could be ascertained by its smell, as well as in the Low Moor iron. The usual solution of iron under analysis, in order to separate these metals from the iron, must be, for the

necessary correction, divided into two parts,—one to be treated with a current of sulphuretted hydrogen, the other part *dropped* into sulphydrate of ammonia, and carefully digested. A small quantity of silica was more difficult to separate from a large quantity of iron than generally seemed to be believed; and the real amount of carbon could *only* be ascertained by Berzelius's method of burning iron in a current of oxygen, or mixed with chlorate of potash and chromate of lead in a glass tube, used first by Berzelius for analysis of organic bodies. The author maintained that steel was an entirely mechanical production of the forge hammer, which tore the molecules of certain species of white cast iron out of their original position, into which the forces of attraction, in respect to the centres as well as to the position of the molecules, had arranged those molecules of the slow action of heat. Steel, as it came out of the converting furnace or the crucible, was nothing more or less than white cast iron, of which Indian steel, called Wootz, was the fairest specimen. The author finally gave an analysis of two specimens of cast iron and one of steel. The first specimen was French gray iron, from Vienne, Department de l'Isere, obtained from a mixture of pea-iron-ore with red hematite, by means of coal from Rive de Gier and heated air, specific gravity 7.898. The second iron was Welsh iron, from the tin-plate manufactory of the Maesteg Ironworks, near Neath, in South Wales, obtained from a mixture of clay iron-stone and Cumberland red ore, by means of coke and heated air. It was silvery white, without signs of crystallization: specific gravity 7.467. The third specimen was a fragment of a razor forged in the author's presence, in the workshop of Mr. Rodgers, of Sheffield, of the specific gravity of 7.92.

| | Gray French Iron. | White Welsh Iron. | Steel. |
|---|---|---|---|
| Silicon | 4.86430 | 1.00867 | 0.52043 |
| Aluminum | 1.00738 | 0.08571 | 0.00000 |
| Manganese | 0.75130 | traces. | 1.92000 |
| Arsenic | 0.00000 | 0.00000 | 0.93400 |
| Antimony | 0.00000 | 1.59710 | 0.12100 |
| Tin | 0.00000 | 0.00000 | traces. |
| Phosphorus | 0.54000 | 0.08553 | 0.00000 |
| Sulphur | 0.17740 | 0.32018 | 1.00200 |
| Azote | 0.00000 | 0.76371 | 0.18310 |
| Carbon | 0.38000 | 4.30000 | 1.42800 |
| Iron | 89.00740 | 91.52282 | 93.79765 |
| Loss | 00.27222 | 00.31428 | 0.09382 |
| | 100.00000 | 100.00000 | 100.00000 |

Several gentlemen, among whom were some connected with the iron trade, expressed a high sense of the value of this communication, from which it appeared that the peculiarities of Swedish iron, in a great degree, depended on the presence of arsenic, and those of Russian iron on the presence of phosphorus. Ibid.

*Observations on the present mode of executing Railways, with suggestions for a more economical, yet equally efficient system, of both executing and working them.* *By* FRANCIS WISHAW, *M. Inst. C. E.*

The author at the commencement of this paper alludes to the principal causes of the great differences between the original estimate and cost of railways. Among these he enumerates the imperfect knowledge of the strata, which occasions the cuttings and embankments to be formed with slopes, which are dangerous, and add to their cost—the imperfect formation of the embankments, especially in clayey soils, which in the opinion of the author ought to be carried up in layers or courses of from 1¼ to 2 yards in thickness, sufficient time being allowed for subsidence before the next layer is added—the cost of stations, which in some of the great lines forms a considerable proportion of the whole cost.

The author then proceeds to suggest means for effecting a considerable saving in the original cost of railways, a certain method of preventing accidents by collision, a saving in the annual expenditure, and a better adaptation of the locomotive engine to its work.

With these views, he proposes a single line of rails—that the line should be divided with intermediate engine stations, three on the London and Birmingham for instance, the engines at each being suited to the prevailing gradient of the district. Thus a line of railway may be more easily laid out, as one or two unfavourable inclines will not affect the working of the whole. At each station there must be a small portion of an additional line of rails, and also at other convenient intervals. The mode of working such line is as follows:—Engines are to start simultaneously in each direction from the terminal and intermediate stations. These engines will pass each other at one of the portions of the double line, and the engine being reversed and taking the other train, will return to the station from whence it started, when another exchange of trains takes place. Thus there is a regular interchange of loads throughout the day, and each engine is confined to its own portion of the line, and it is impossible that a collision can take place. Equal accommodation would be afforded to the public, and the engine man, from being always confined to the same small portion of the line, would be perfectly conversant with every part of it. The saving which would on this system be effected on the original cost is estimated at more than £5000 per mile. Lond. Jour. Arts & Sci.

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*On the Marquis of Tweeddale's Patent Brick and Tile Machine.* *By* MR. G. COTTAM.

The first process by this machine is to make a continuous sheet of well-pressed clay, of the proper breadth and thickness. This is then cut into the required lengths. It moulds at the rate of 24 bricks per minute, or 1,440 per hour, and, in a brick-maker's day of 16 hours would produce 23,040 per day; and, in consequence of the compression which the clay undergoes, the bricks do not require one-third of the time to dry them that the hand-made bricks do. The tile machine is a modification of that of bricks. In each case, the clay is made to pass between two rollers, from whence it is brought out in a thin flat cake, and is cut to the requisite width by two wires. It is then conveyed, by an endless web, under other rollers, and, by a simple contrivance, the tiles are cut to the required size, the web farther conveying them on to the shelves from whence they are taken to be burnt. By a modification of the

machine, the drain-tile and the pan-tile can be manufactured with equal facility.

In a subsequent conversation, Mr. Cottam mentioned some experiments which had been made on the power of absorption possessed by these bricks in comparison with those made by hand. One of the latter being put into water for six hours, absorbed 28 oz. of water, while a machine-made brick absorbed but 4 oz. Their solidity had also been compared, and this was also much in favour of the machine bricks, the weight of one of which was 8 lb. 19 dr., whilst one of the hand-made bricks of similar size was but 5¼ lb. There is now a manufactory in full operation at York, where about 15,000 per week were produced. The endless web on which the clay ran was moleskin cloth, or velveteens, and which, from the numerous points which it presents, prevents adhesion. Athenæum.

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### *Royal Geological Society of Cornwall.*

### *Boring Granite Rocks.*

Mr. Pridaux observed, that a year or two since it had been suggested to him whether some chemical process could not be adopted to bore hard rocks. After some consideration, and trying several experiments, he at last found that a stream of hydrogen-oxygen gas applied to a piece of granite soon produced heat, and on the application of cold water the stone became soft, and yielded to the tool. He repeated the experiment with the same result in every case. Mr. P. then explained how the gases should be mixed, and how it might be infused into the hole in the rock. He also said that a great deal of the difficulty of getting the gas at the bottom of the mines might be obviated by very simple means. Oxygen might be superseded by common air from a pair of double bellows; and the common coal gas would be found better than hydrogen, because it contained more inflammable matter in a given space, and it might be procured from any neighbouring gas-works, and conveyed down into a mine in a copper vessel. (Mr. Prideaux explained the kind of vessel by diagram.) If, said Mr. Prideaux, oxygen gas should be found absolutely necessary, nothing was easier to procure where there was a steam engine; they had only to get a little iron retort, and in a county like Cornwall, abounding with manganese, they need never be at a loss for oxygen gas. He did not, however, suppose, in the present state of underground management in our mines, this plan would be adopted, but he was of opinion, should the Mining School be continued for two or three years, there would soon be many young men ready to carry it into effect. Mining Review.

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### *On Tubing the Boilers of Locomotive Engines. By* George Buck, *M. Inst. C. E.*

In this communication, the author has attempted to determine the diameter of the tubes of the boiler of a locomotive engine, so that the effect in the generation of steam may be a maximum. The following are the conditions upon which the problem is solved: That the evaporating effect of the hot air, in passing through the tubes, is in proportion to the extent of surface in contact with the hot air, and as the time of contact conjointly. The following are the results of the investigation: The distance between the centres of two adjacent tubes should be equal to four times the interval between their internal surfaces—the diameter of each tube should be equal to three times the same interval—that the tubes should be as near each other as possible.

In illustration, Mr. Buck has drawn two sets of tubes of the locomotive boiler as generally employed, and one as they would be arranged according to the results of this investigation. On comparing the products of the aggregate periphery, and the aggregate area of the tubes, it appears that the boiler tubed according to the above theoretic proportion is from 23 to 26 per cent. superior to others.

Inst. Civ. Eng.

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*On Mr. Smeaton's estimate of Animal Power, extracted from his MS. Papers. By* JOHN FAREY, *M. Inst. C. E.*

The amount of mechanical power has been frequently over-stated, in consequence of the conclusions being drawn from efforts continued for too short a time. Desaguliers estimated the power of a man as equal to raising 5507 lbs. one foot high per minute; this was found by Smeaton to be too high; several experiments are recorded, in which different values are assigned to the power of a man, and he ultimately fixed it at about $\frac{2}{3}$rds of the above, or 3672 lbs. Several experiments are recorded of the estimate of the power of a horse, and of the quantity of water raised by various machines.

The communication is accompanied by a letter in Mr. Smeaton's handwriting, dated 21st Feb. 1789.

Ibid.

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## Mechanics' Register.

*The Daguerreotype.*

One great obstacle to the use of M. Daguerre's photogenic process, is the difficulty of preserving the pictures when completed, because they are of so delicate a nature, and so easily injured, that the slightest touch effaces them —even M. Daguerre himself has always found it necessary to protect them with a plate of glass, which is both incovenient and troublesome; and it has, in consequence, been suggested, that if a varnish could be discovered which might be easily applied to the surface of the plates after the completion of the pictures, and which, whilst it protected them from injury, should not impair their delicacy, it would considerably add to the value and usefulness of the process:—we are happy, therefore, to hear, that M. Dumas has discovered, that a liquid, composed of one part of *dextrine* and five parts of water, forms a varnish of the desired nature. It is said to be well adapted for the purpose, and further possesses the advantage of being easily removed from the surface of the picture, by immersing the whole in boiling water. Time, however, will be required to ascertain whether this varnish has any action on the peculiar mercurial compound of which the image is formed.

Athenæum.

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*Zarskojeselo Railroad.*

At a general meeting of the shareholders in this railroad, lately held at St. Petersburgh, it appeared by the report of the directors that the cost of the formation of the road and its *materiel* had amounted to 5,281,667 roubles. The original calculations were founded upon the anticipation of 300,000 passengers within the year, but, during the preceding twelve months, the number of travellers between the capital and Zarskojeselo had amounted to 500,000, and the number which passed along the whole line to and from Paulowsk was 707,091. The receipts amounted to 920,237 roubles. At the end of the first nine months the recepts exceeded the expenditure by 316,976 roubles. Of this balance 90,000 roubles were applied in paying the in-

terest and reimbursing the loan from the Crown; and 140,000 roubles to the payment of interest on shares; 15,848 roubles were divided, according to the statutes, among the directors; 1555 roubles were paid to the chief engineer; and 69,572 roubles were carried to the reserved fund. Mining Jor.

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### *Magnetic effect of Lightning.*

[Extract of a letter from Malta.]

After the mainmast of H. M. S. *Rodney*, was struck by lightning during her late passage from Athens to this place, the broken hoops surrounding it were all found to be magnetized, in the same uniformity of direction as if they had been operated on in one direction also by the galvanic helix. Thus, in a hoop broken in two athwart-ships (speaking with reference to the ship's head,) the larboard end of the foremost portion was a south and its starboard a north pole; the end of the aftermost portion in contact with the south pole of the foremost portion being, consequently, a north pole, and the other end thereof a south; and so uniformly with all the other hoops, at whatever part they were broken; similar poles in each hoop always pointing in similar directions in the circumference of the respective circles. Athenæum.

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## Notices.

*Proposed exchange of Minerals.*—The subscriber has recently made a large collection of the minerals of NovaScotia, formerly discovered by Dr. Jackson and himself, and is desirous of exchanging suits of them for the minerals of other regions, foreign or domestic. The specimens have been selected with great care, are of good size, and generally well crystallized, often uniting in the same specimen several different species. They comprize nearly all the species of the Kouphine spars of Mohs and Haidenger; rhomboidal or uncleavable quartz; most of the varieties of quartz, agate, jasper, amethyst, &c., besides many interesting ores, salts of lime, &c., &c. By referring to the 14th and 15th volumes of Silliman's Journal, or to the 1st volume, new series, of the Transactions of the American Academy, a particular notice of these minerals will be found, in a memoir on the Geology and Mineralogy of Nova Scotia.

Those persons who may wish to exchange are requested to forward to the subscriber, in Boston, a list of such mineral as they may wish to dispose of, before sending the specimens, as his cabinet is already well supplied, and it is his wish to select such, principally, as are not already contained in it.

FRANCIS ALGER.

*Boston, Mass. February 1st*, 1840.

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*Manual of Chemistry.*—In the press of March, Capen, Lyon, and Webb, Boston, An abridgment of Webster's Manual of Chemistry, (recently published) for the use of schools and academies. Also OUTLINES OF MINERALOGY, by Thomas Thomson, M. D., with alterations and additions by Prof. J. Webster. Intended as a text book for persons attending lectures, &c.

The communication of new localities of American minerals is particularly requested, addressed to the publishers in Boston.

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*American Repertory.*—A new monthly periodical under the above title, and devoted to Arts, Sciences, and Manufactures, has been commenced in New York, under the Editorship of Prof. Jas. J. Mapes, who is advantageously known as a gentleman of science, and practical skill.

| LUNAR OCCULTATIONS FOR PHILADELPHIA, APRIL, 1840. | | | | | Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜ | |
|---|---|---|---|---|---|---|
| Day. | H'r. | Min. | Star's name. | Mag. | From Moon's North point. | From Moon's Vertex. |
| 11 | 9 | 8 | Im. α Leonis | 1 | 104° | 116° |
| 11 | 9 | 56 | Em. | | 180 | 208 |
| 19 | 15 | 21 | Im. τ Scorpii | 3, 4 | 30 | 40 |
| 19 | 16 | 17 | Em. | | 314 | 335 |

## *Meteorological Observations for November*, 1839.

| Moon. | Days | Therm. Sun rise. | Therm. 2 P.M. | Barometer. Sun rise. | Barometer. 2 P.M. | Wind. Direction | Wind. Force. | Water fallen in rain. | State of the weather, and Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Inch's | Inch's | | | Inches. | |
| | 1 | 41 | 49 | 29.80 | 29.80 | W. | Moderate. | | Clear—lightly cloudy. |
| | 2 | 38 | 49 | .85 | .85 | W.N.E. | do. | | Partially cloudy—do. |
| | 3 | 40 | 50 | .90 | .94 | N.E. | do. | | Partially cloudy—do. |
| | 4 | 38 | 46 | .94 | .90 | N.E. | do. | | Cloudy—do. |
| ⊗ | 5 | 37 | 46 | .70 | .83 | E. | do. | | Cloudy—rain. |
| | 6 | 42 | 51 | .40 | .40 | W. | Brisk. | | Clear—do. |
| | 7 | 39 | 46 | .40 | .44 | W. | do. | | Flying clouds—do. |
| | 8 | 36 | 45 | .65 | .73 | W. | do. | | Cloudy—do. |
| | 9 | 34 | 46 | .84 | .86 | W. | do. | | Cloudy—flying clouds. |
| | 10 | 36 | 41 | .95 | .96 | W. | do. | | Cloudy—flying clouds. |
| | 11 | 30 | 45 | 30.10 | 30.12 | W. | Moderate. | | Clear—do. |
| | 12 | 28 | 46 | .05 | .05 | E. | Calm. | | Clear—cloudy. |
| ☾ | 13 | 28 | 54 | 29.95 | 29.95 | W. | do. | | Flying clouds—clear. |
| | 14 | 47 | 54 | .90 | .83 | E. | do. | .2 | Drizzle—do. |
| | 15 | 52 | 60 | .80 | .70 | W. | do. | .8 | Partially cloudy—do.—rain. |
| | 16 | 38 | 49 | 30.10 | 30.10 | W. | Moderate. | | Clear—clear. |
| | 17 | 37 | 50 | .20 | .10 | S.W. | do. | | Cloudy—do. |
| | 18 | 36 | 52 | 29.90 | 29.80 | W. | Blustering | | Partially cloudy—clear. |
| ♈ | 19 | 44 | 46 | .55 | .55 | W. | do. | | Partially cloudy—clear. |
| | 20 | 30 | 37 | .70 | .75 | N.W. | do. | | Clear—flying clouds. |
| | 21 | 23 | 26 | 30.05 | 30.10 | W. | do. | | Clear—flying clouds. |
| | 22 | 20 | 32 | .45 | .55 | N.W. | Brisk. | | Clear—do. |
| | 23 | 20 | 34 | .55 | .55 | N. | Moderate. | | Clear—do. |
| | 24 | 37 | 49 | .18 | .08 | E. | Calm. | | Rain—do. |
| | 25 | 46 | 43 | 29.77 | 29.80 | N.W. | do. | 1.55 | Rain—flying clouds. |
| | 26 | 15 | 24 | 30.14 | 30.28 | W. | Moderate. | | Clear—do. |
| ☽ | 27 | 20 | 34 | .30 | .20 | W. | do. | | Clear—do. |
| | 28 | 30 | 40 | .15 | .15 | W. | Calm. | | Cloudy—clear. |
| | 29 | 30 | 48 | .10 | .10 | E. | do. | | Cloudy—do. |
| | 30 | 38 | 48 | .06 | .05 | E. | do. | | Cloudy—do. |
| | Mean | 34.33 | 44.67 | 29.95 | 29.95 | | | 1.65 | |

| | Thermometer. | | Barometer. | |
|---|---|---|---|---|
| Maximum height during the month. | 60.00 | on 15th. | 30.55 | on 22nd. & 23rd. |
| Minimum " " | 15.00 | 25th. | 29.40 | 6th. & 7th. |
| Mean | 39.00. | | 29.95 | |

# METEOROLOGICAL REPORT

FOR THE STATE OF PENNSYLVANIA,

Collated from returns made to the Committee on Meteorology of the Franklin Institute of the State of Pennsylvania, for

FEBRUARY, 1840.

| | County. | Town. | Observer. | Thermometer. 7, A. M. | 2, P. M. | 9, P. M. | Maximum. | Minimum. | Mean. | Days omitted. | Register. Lowest. | Mean. | Days omitted. | Barom. 7, A. M. | 2, P. M. | 9, P. M. | Maximum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Philadelphia, | | | | | | | | | | | | | | | | |
| 2 | Montgomery, | | | | | | | | | | | | | | | | |
| 3 | Bucks, | Newtown, | L. H. Parsons, | 32.72 | 44.55 | 36.60 | 68.00 | — 1.00 | 37.96 | 1/3 | — 6.00 | 28.00 | . | 30.15 | 30.11 | 30.12 | 30.5 |
| 4 | Lehigh, | | | | | | | | | | | | | | | | |
| 5 | Northampton, | Easton, | Lafayette College, | 30.07 | 39.48 | 34.83 | 64.00 | — 2.00 | 34.79 | . | .... | .... | . | .... | .... | .... | .... |
| 6 | Monroe, | Stroudsburg, | A. M. Stokes, | 28.28 | 38.79 | 33.20 | 65.00 | 0.00 | 33.42 | 5 | .... | .... | . | 29.63 | 29.62 | 29.40 | 30.0 |
| 7 | Pike, | | | | | | | | | | | | | | | | |
| 8 | Wayne, | | | | | | | | | | | | | | | | |
| 9 | Susquehanna, | Silver Lake, | E. W. Rose, | 25.69 | 35.38 | 30.28 | 55.00 | — 4.00 | 30.45 | . | —10.00 | 23.10 | . | 28.07 | 28.06 | 28.08 | 28.3 |
| 10 | Luzerne, | Wilkesbarre, | W. F. Dennis, | 28.41 | 42.61 | 34.17 | 70.00 | — 3.00 | 35.06 | 1/3 | — 2.00 | 26.10 | . | 29.45 | 29.42 | 29.43 | 29.7 |
| 11 | Schuylkill, | | | | | | | | | | | | | | | | |
| 12 | Berks, | Reading, | C. F. Egelmann, | 32.76 | 39.34 | 36.10 | 62.00 | 2.00 | 36.07 | . | .... | .... | . | 29.91 | 29.94 | 29.91 | 30.2 |
| 13 | Chester, | | | | | | | | | | | | | | | | |
| 14 | Delaware, | Haverford, | Haverford School, | 33.67 | 44.81 | 39.22 | 68.00 | 4.00 | 39.23 | 3 1/3 | 4.00 | 31.57 | 1 | 29.59 | 29.63 | 29.62 | 30.0 |
| 15 | Lancaster, | Lancaster, | Conservatory of Arts, | 34.60 | 46.57 | 37.80 | 69.50 | 2.00 | 39.66 | 1/3 | 2.00 | 30.86 | . | 29.62 | 29.58 | 29.59 | 29.9 |
| 16 | York, | | | | | | | | | | | | | | | | |
| 17 | Lebanon, | | | | | | | | | | | | | | | | |
| 18 | Dauphin, | | | | | | | | | | | | | | | | |
| 19 | Northumberland, | Northumberland, | Andrew C. Huston, | 30.33 | 42.16 | 35.31 | 64.00 | 4.00 | 35.93 | . | — 1.00 | 26.48 | . | 29.56 | 29.50 | 29.53 | 29.8 |
| 20 | Columbia, | | | | | | | | | | | | | | | | |
| 21 | Bradford, | | | | | | | | | | | | | | | | |
| 22 | Tioga, | | | | | | | | | | | | | | | | |
| 23 | Lycoming, | | | | | | | | | | | | | | | | |
| 24 | Union, | | | | | | | | | | | | | | | | |
| 25 | Mifflin, | | | | | | | | | | | | | | | | |
| 26 | Juniata, | Mifflintown, | J. A. Rinkead, | 28.17 | 44.27 | 34.89 | 63.00 | — 2.00 | 35.78 | 1 1/3 | .... | .... | . | 29.52 | 29.54 | 29.54 | 29.9 |
| 27 | Perry, | | | | | | | | | | | | | | | | |
| 28 | Cumberland, | Carlisle, | Prof. W. H. Allen, | 29.24 | 41.07 | 34.90 | 65.00 | — 5.00 | 35.07 | 1/3 | — 5.00 | 27.31 | . | 29.50 | 29.47 | 29.46 | 29.7 |
| 29 | Adams, | Gettysburg, | Prof. M. Jacobs, | 30.69 | 44.72 | 37.25 | 65.00 | — 3.00 | 37.56 | . | — 3.00 | 28.25 | . | 29.50 | 29.46 | 29.48 | 29.7 |
| 30 | Franklin, | | | | | | | | | | | | | | | | |
| 31 | Huntingdon, | Huntingdon, | Jacob Miller, | 30.83 | 43.48 | 34.68 | 66.00 | 2.00 | 36.33 | 1 | 1.00 | 26.60 | . | 29.45 | 29.36 | 29.41 | 29.7 |
| 32 | Centre, | Bellefonte, | John Harris, | 27.28 | 40.03 | 31.96 | 62.00 | —10.00 | 33.09 | 1/3 | —13.00 | 21.74 | 2 | 29.32 | 29.31 | 29.37 | 29.6 |
| 33 | Potter, | | | | | | | | | | | | | | | | |
| 34 | M'Kean, | Smithport, | Richard Chadwick, | 25.48 | 40.14 | 28.30 | 62.00 | —12.00 | 31.31 | 1/3 | —12.00 | 21.14 | 1 | 28.16 | 28.17 | 28.15 | 28.4 |
| 35 | Clearfield, | | | | | | | | | | | | | | | | |
| 36 | Cambria, | Ebensburgh, | Richard Lewis, | 29.03 | 41.63 | 33.90 | 62.00 | 0.00 | 34.85 | 2/3 | .... | .... | . | 27.81 | 27.81 | 27.82 | 28.1 |
| 37 | Bedford, | Bedford, | Samuel Brown, | 35.04 | 49.39 | 43.19 | 69.40 | 18.00 | 42.54 | 5 2/3 | .... | .... | . | 29.26 | 29.20 | 29.23 | 29.5 |
| 38 | Somerset, | Somerset, | George Mowry, | 30.79 | 44.29 | 36.40 | 61.00 | —10.00 | 37.16 | 1/3 | .... | .... | . | 28.04 | 28.02 | 28.01 | 28.2 |
| 39 | Indiana, | Indiana, | Richard White, | 34.70 | 46.10 | 36.14 | 71.00 | 1.00 | 38.98 | . | .... | .... | . | 28.65 | 28.59 | 28.62 | 28.9 |
| 40 | Jefferson, | Rose Cottage, | C. C. Gaskell, | 25.96 | 37.42 | 29.25 | 50.00 | —12.00 | 30.88 | 3 | .... | .... | . | 28.94 | 28.90 | 28.91 | 29.2 |
| 41 | Warren, | Warren, | R. Brown, | 29.76 | 44.53 | 30.96 | 67.00 | — 3.00 | 35.08 | 2/3 | .... | .... | . | 28.82 | 28.83 | 28.84 | 29.5 |
| 42 | Venango, | Franklin, | Wm. Connelly, | 29.10 | 44.00 | 36.79 | 72.00 | 0.00 | 36.63 | . | .... | .... | . | 29.15 | 29.03 | .... | 29.5 |
| 43 | Armstrong, | | | | | | | | | | | | | | | | |
| 44 | Westmoreland, | | | | | | | | | | | | | | | | |
| 45 | Fayette, | | | | | | | | | | | | | | | | |
| 46 | Green, | | | | | | | | | | | | | | | | |
| 47 | Washington, | | | | | | | | | | | | | | | | |
| 48 | Allegheny, | | | | | | | | | | | | | | | | |
| 49 | Beaver, | | | | | | | | | | | | | | | | |
| 50 | Butler, | Butler, | Jacob Mechling, | 29.02 | 45.34 | 35.67 | 70.00 | — 6.00 | 36.68 | . | .... | .... | . | .... | .... | .... | .... |
| 51 | Mercer, | West Greenville, | John Keck, | 35.18 | 42.80 | 40.35 | 63.00 | 6.00 | 39.44 | 2 2/3 | ... | .... | . | 28.84 | 28.78 | 28.76 | 29.4 |
| 52 | Crawford, | Meadville, | J. Limber, | 33.52 | 47.84 | 39.36 | 65.00 | 10.00 | 40.24 | 4 | 10.00 | 29.78 | 6 | 28.76 | 28.72 | 28.73 | 29.0 |
| 53 | Erie, | Erie, | Park & Reid, | 31.69 | 39.89 | 26.10 | 66.00 | 8.00 | 32.56 | . | 5.00 | 23.00 | . | 29.48 | 29.46 | 29.45 | 29.8 |

| Barometer. | | | | Weather. | | | | | | | | Winds. | | | | | | | | | | | | | | | Hygrometer | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum. | Minimum. | Mean. | Days omitted. | Clear. | Cloudy. | Days omitted. | Rain. | Snow. | Rain and Snow. | Thunder Showers. | Rain in inches. | North. | N. N. E. | N. E. | E. N. E. | East. | E. S. E. | S. E. | S. S. E. | South. | S. S. W. | S. W. | W. S. W. | West. | W. N. W. | N. W. | N. N. W. | Calm. | Days omitted. | Dew-point. | Days omitted. | Diff. therm. and dew point. | Wet Bulb. |
| 30.54 | 29.58 | 30.13 | ⅓ | 9⅔ | 18⅓ | 1 | .... | .... | .... | .. | 3.385 | . | . | 4⅓ | ⅓ | . | . | 3⅓ | . | ⅓ | . | 7⅔ | . | ⅔ | . | 12 | . | . | ⅓ | .... | . | ..... | ... |
| .... | .... | ... | . | . | . | . | .... | .... | .... | .. | ..... | 10⅓ | ⅔ | 5 | . | 3 | . | 3 | . | 3 | . | 3 | . | . | . | 1 | . | . | . | .... | . | ..... | ... |
| 30.05 | 29.00 | 29.55 | 3⅔ | 6 | 20 | 3 | .... | .... | .... | .. | ..... | 2⅔ | ⅔ | 1⅔ | . | 2⅔ | . | ⅓ | . | 1⅔ | ⅓ | 4 | . | 7⅓ | . | 2⅓ | 1 | . | 4⅔ | .... | . | ..... | ... |
| 28.30 | 27.50 | 28.07 | . | 10⅔ | 18⅓ | . | 6 | 1 | .... | .. | 1.990 | 1⅓ | . | . | . | . | . | 1⅓ | . | 3⅓ | . | 5 | . | 9⅓ | . | 5 | . | 3⅔ | . | .... | . | ..... | ... |
| 29.73 | 28.69 | 29.43 | ⅓ | 10⅓ | 18⅓ | ⅓ | .... | .... | .... | .. | 2.191 | 3 | . | 2⅓ | . | . | ⅓ | . | . | 4⅔ | ⅔ | 7 | ⅓ | 4 | . | 5⅓ | 1⅓ | . | . | 26.40 | 4 | ..... | ... |
| 30.25 | 29.22 | 29.93 | . | 9⅔ | 19⅓ | . | 8 | 1 | 1 | .. | ..... | . | . | . | . | 1⅔ | . | 6⅓ | . | ⅔ | ⅓ | 6 | . | 1⅓ | . | 9 | 2⅔ | ⅓ | . | .... | . | ..... | ... |
| 30.02 | 28.92 | 29.61 | ⅓ | 6 | 22⅔ | ⅓ | .... | .... | .... | .. | 3.108 | 2 | ⅓ | 2 | . | 1⅓ | . | ⅓ | . | 3⅓ | 1⅓ | 6⅔ | . | 1 | ⅔ | 4⅓ | 1 | 1⅔ | 3 | 35.17 | 5 | ..... | ... |
| 29.96 | 28.87 | 29.60 | ⅔ | 11⅔ | 17 | ⅓ | 10 | 2 | .... | .. | 2.151 | 1⅓ | ⅓ | 1⅔ | 2 | 2⅓ | 1⅓ | 1 | 1⅓ | 3 | 1⅓ | 3⅔ | ⅓ | 1⅓ | 1 | 3⅔ | 3 | . | ⅓ | 36.49 | 2 | ..... | 41.8 |
| 29.89 | 28.84 | 29.53 | . | 5⅓ | 23 | ⅔ | 5 | 3 | 1 | .. | 2.645 | 6 | . | ⅔ | . | 1⅓ | . | 3⅓ | ⅓ | 4⅓ | . | ⅓ | . | 4⅓ | ⅓ | 4 | . | 4 | . | .... | . | ..... | 45.0 |
| 29.90 | 28.80 | 29.53 | 1⅔ | 11⅓ | 15⅔ | 2 | .... | .... | .... | .. | ..... | . | . | 2 | . | ⅓ | . | 1⅔ | . | . | . | 1⅔ | . | 1 | . | 7 | . | 13⅔ | 1⅔ | .... | . | ..... | ... |
| 29.76 | 28.83 | 29.48 | ⅓ | 7⅔ | 21 | ⅓ | 6 | 1 | .... | 1 | 1.787 | ⅓ | . | ⅔ | . | 1⅔ | . | 1⅔ | ⅓ | . | . | 3⅔ | . | 3⅔ | . | 3⅓ | ⅓ | 13 | ⅓ | .... | . | ..... | ... |
| 29.75 | 28.84 | 29.48 | . | 11⅓ | 17⅓ | ⅓ | .... | .... | .... | .. | 1.977 | 6 | ⅓ | ⅔ | . | ⅓ | . | . | ⅓ | 4⅓ | 3⅓ | 2⅔ | . | 1⅔ | 1 | 2⅓ | ⅔ | 5⅔ | . | .... | . | ..... | ... |
| 29.76 | 28.78 | 29.41 | 1 | 17 | 12 | . | 1 | 1 | .... | 1 | ..... | ⅓ | . | . | . | 5 | . | . | . | ⅔ | . | . | . | 16⅓ | . | 6⅓ | . | . | ⅓ | .... | . | ..... | ... |
| 29.66 | 28.64 | 29.33 | 1 | 8 | 20 | 1 | .... | .... | .... | .. | 2.050 | 1 | ⅓ | 4 | . | 1⅓ | . | ⅔ | . | . | . | 5⅓ | ⅓ | 1⅔ | ⅓ | 12⅓ | . | ⅓ | 1⅓ | .... | . | ..... | ... |
| 28.45 | 27.60 | 28.16 | ⅔ | 5⅓ | 23 | ⅔ | .... | .... | .... | .. | 2.175 | . | . | . | . | 4⅓ | . | 3⅔ | . | . | . | 6⅔ | . | 3⅓ | . | 8⅔ | . | ⅓ | 2 | .... | . | ..... | 40.5 |
| 28.10 | 27.20 | 27.81 | ⅔ | 10 | 17⅔ | 1⅓ | .... | .... | .... | .. | 1.209 | . | . | . | . | ⅔ | . | 2 | . | 2⅓ | . | 7⅓ | . | 9⅓ | 1 | 1⅔ | . | 4 | ⅔ | .... | . | ..... | ... |
| 29.53 | 28.61 | 29.23 | 5⅔ | 8 | 15⅓ | 5⅔ | .... | .... | .... | .. | ..... | . | . | . | . | . | 1⅔ | . | ⅔ | . | 1⅔ | 1 | 10⅔ | 2 | 4 | . | 2⅔ | . | 5 | .... | . | .. . | ... |
| 28.26 | 27.57 | 28.02 | ⅓ | 9 | 19⅔ | ⅓ | .... | .... | .... | .. | 1.712 | . | . | . | . | . | ⅓ | . | . | 5 | . | 6 | 4⅓ | 4 | 2 | 1⅓ | . | 5⅔ | ⅓ | .... | . | ..... | ... |
| 28.90 | 28.00 | 28.62 | . | 10⅓ | 18⅔ | . | 10 | 3 | .... | .. | 3.051 | . | . | . | . | ⅓ | . | ⅔ | . | 3⅓ | . | ⅔ | . | 5⅓ | . | 3⅔ | . | 14⅔ | . | .... | . | ... | ... |
| 29.20 | 28.40 | 28.92 | 2⅔ | 6⅓ | 20 | 2⅔ | .... | .... | .... | .. | 2.920 | . | . | . | . | . | . | ⅔ | . | . | . | 4 | ⅔ | 3⅔ | ⅓ | 1 | . | 15⅔ | 3 | .... | . | ... . | ... |
| 29.50 | 28.20 | 28.83 | ⅔ | 6⅔ | 21⅔ | ⅔ | .... | .... | ... | .. | ..... | 2⅔ | . | ⅓ | . | . | . | ⅓ | . | 6 | . | 1⅓ | . | 5⅓ | . | 1⅔ | . | 10⅓ | ⅔ | .... | . | .... | ... |
| 29.59 | 28.50 | 29.09 | 17⅔ | . | . | . | .... | .... | .... | .. | 2.430 | . | . | . | . | . | . | 2⅓ | . | . | . | 3⅔ | . | . | . | 3⅔ | . | . | 19⅓ | .... | . | ..... | ... |
| .... | .... | .... | . | . | . | . | .... | .... | .... | .. | 2.312 | . | . | . | . | 5 | . | 1⅓ | . | 2⅓ | . | 12 | . | 7⅔ | . | ⅔ | . | . | . | .... | . | ..... | ... |
| 29.44 | 28.22 | 28.79 | 2⅔ | 3⅔ | 10⅓ | 15 | .... | .... | .... | .. | ..... | 4 | . | . | . | . | . | . | . | 22 | . | . | . | . | . | . | . | . | 3 | .... | . | ..... | ... |
| 29.09 | 28.10 | 28.74 | 4 | 6⅔ | 18⅓ | 4 | .... | .... | .... | .. | ..... | ⅔ | . | ⅔ | . | . | 1 | 6⅔ | 1 | 2⅓ | . | 3 | . | 1⅓ | ⅔ | 4⅔ | ⅓ | 5⅓ | 6½ | .... | . | ..... | ... |
| 29.85 | 28.69 | 29.46 | . | 6⅓ | 22⅔ | . | 5 | 2 | .... | .. | 2.010 | ⅔ | 1 | ⅔ | . | ⅓ | . | 1⅔ | 1⅔ | 5⅔ | ⅔ | 2 | 1 | 4 | ⅓ | 3⅔ | ⅔ | 5⅓ | . | .... | . | ..... | ... |

**ygrometer.**

| Days omitted. | Diff. therm. and dew point. | Wet Bulb. | Days omitted. | No. of Report. |
|---|---|---|---|---|
| . | ..... | .... | . | 982 |
| . | ..... | .... | . | 977 |
| . | ..... | .... | . | 988 |
| . | ..... | .... | . | 970 |
| 4 | ..... | .... | . | 1045 |
| . | ..... | .... | . | 1056 |
| 5 | ..... | .... | . | 989 |
| 2 | ..... | 41.85 | 2 | 974 |
| . | ..... | 45.00 | . | 960 |
| . | ..... | .... | . | 965 |
| . | ..... | .... | . | 961 |
| . | ..... | .... | . | 1013 |
| . | ..... | .... | . | 995 |
| . | ..... | .... | . | 967 |
| . | ..... | 40.54 | 3 | 1007 |
| . | ..... | .... | . | 962 |
| . | .. . | .... | . | 964 |
| . | ..... | .... | . | 1043 |
| . | ... | .... | . | 992 |
| . | ... . | .... | . | 979 |
| . | .... | .... | . | 976 |
| . | ..... | .... | . | 968 |
| . | ..... | .... | . | 963 |
| . | ..... | .... | . | 1046 |
| . | ..... | .... | . | 975 |
| . | ..... | .... | . | 980 |